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# Pattern Plates for Molding Machine Work

*How they are made, with illustrations of the various operations—The use of plates for stove castings*

PATTERN plates are almost an indispensable adjunct to the molding machine of the squeezer type. Castings made in this way are much more accurate than those produced from ordinary patterns or by hand molding, and if they have to be machined a large percentage of the fitting cost is avoided. The use of pattern plates in connection with a molding machine also makes the entire process purely mechanical. As a result, the work is done with a uniformity which lowers the number of discounts in each day's heat, in some cases to an almost negligible quantity. Furthermore, plated patterns are not subject to the damages encountered by ordinary patterns and are less expensive in the long run. For use in connection with its

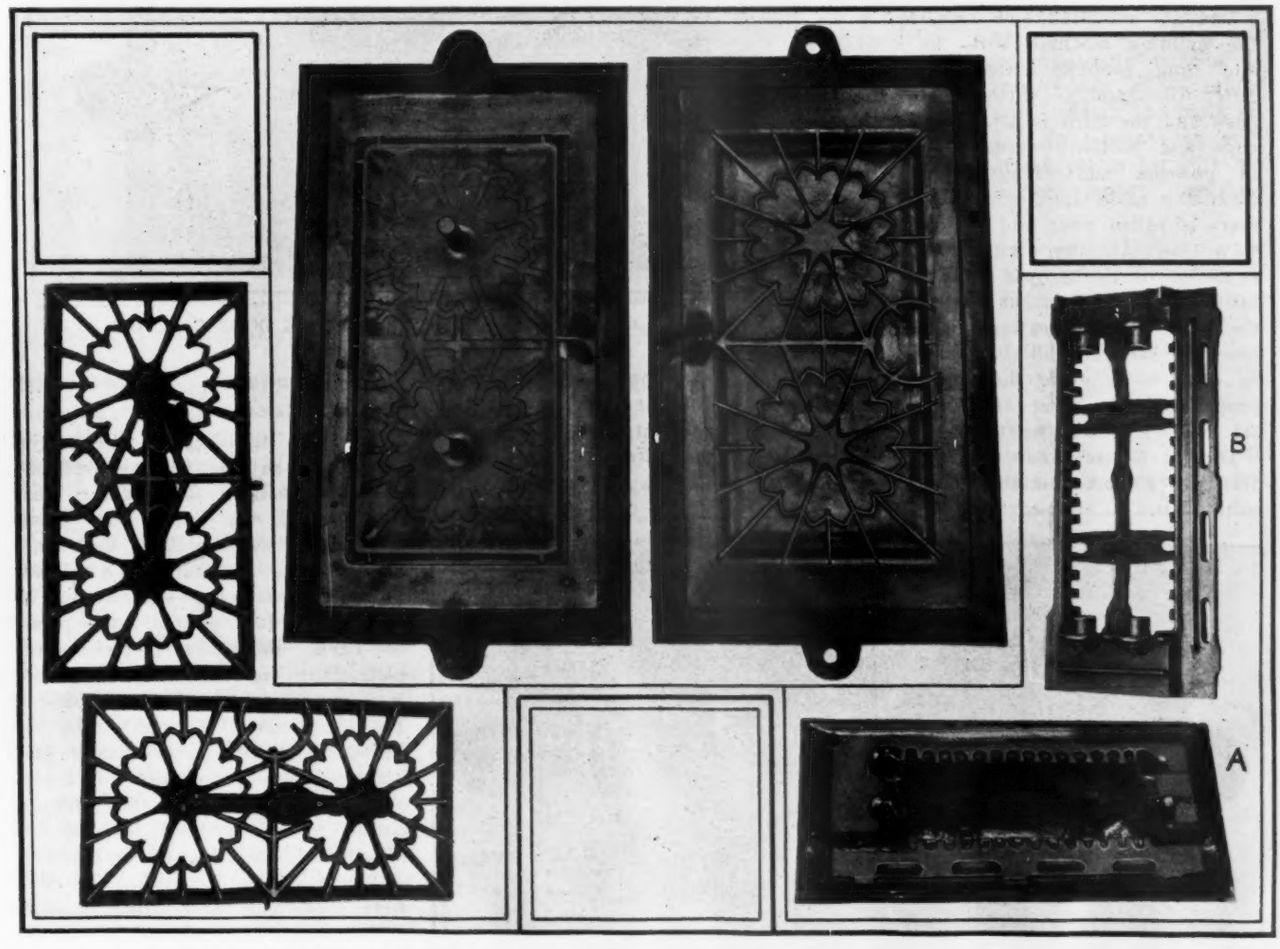



FIG. 1—DRAG AND COPE SIDES OF GAS STOVE TOP CASTING

FIG. 3—PLASTER PATTERN FOR GRATE FRAME PLATE AT *A*; MASTER PATTERN AT *B*

FIG. 2—COPE AND DRAG PATTERN PLATES FOR GAS STOVE TOP

FIG. 4—FACE OF PLASTER MATCH-PLATE IN FRAME

squeezer machines the Arcade Mfg. Co., Freeport, Ill., has developed a system of making and applying pattern plates, some of the details of which will be described in this article. The plates are made in pairs from ordinary gated metal patterns, two plates being employed, one for the cope and the other for the drag portions of the pattern. These two plates are mounted side by side on the molding machine with the cope and drag properly fitted to them. After the sand is thrown into the flask and the surplus scraped off, the cope and bottom boards are placed in position and clamped properly. Next the table upon which the flask rests is rolled over and the mold is then mechanically rammed or squeezed to the proper density. By raising a long lever at the side of the machine the pattern is drawn from the sand and all that remains to be done is to place the cope in its proper position over the drag and set the mold on the floor.

Thus it is seen that the cope and drag are rammed simultaneously, resulting in a time-saving on each mold of fully 30 per cent over that required when the two parts of the flask are rammed successively. Pattern plates are an essential part of this process, since without them it would not be possible to ram both cope and drag at once.

At this point it would be well to mention the difference between a match-plate and a pattern plate, since the two are often confused. A match-plate has the pattern mounted on both sides, the portions on each side being matched, that is, placed exactly opposite each other so that if the plate were suddenly removed the two halves of the pattern would come together accurately. In a pattern plate, however, the patterns are mounted on one side of the plate only. Pattern plates are always used in pairs, one for the cope and one for the drag, the proper half of the split pattern being mounted on each plate; match-plates are used singly and fit between the cope and the drag when they are being rammed.

The various stages in the production of a pair of typical pattern plates are shown in Figs. 4, 5, 6, 7, 10 and 11. Figs. 4 and 5 show the plaster patterns, Figs. 10 and 11 the back of the plates and Figs. 6 and 7 the finished or working side of the plates. The castings are stove doors, there being two in each flask; the gates are clearly shown in the drag plate, Fig. 7.

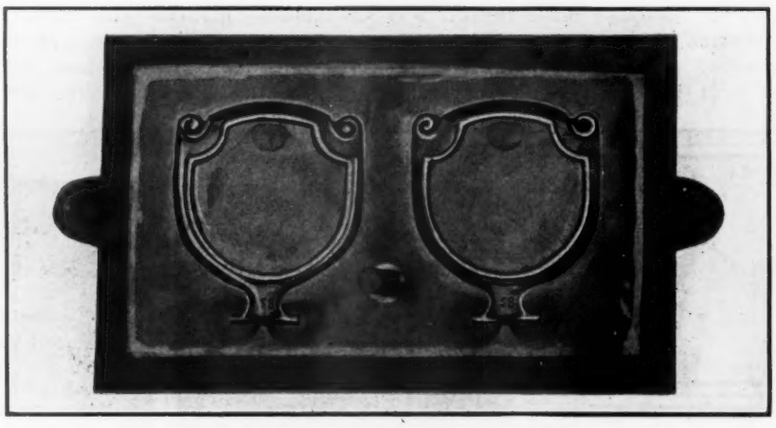


FIG. 6—COPE PATTERN PLATE FOR STOVE DOOR CASTINGS

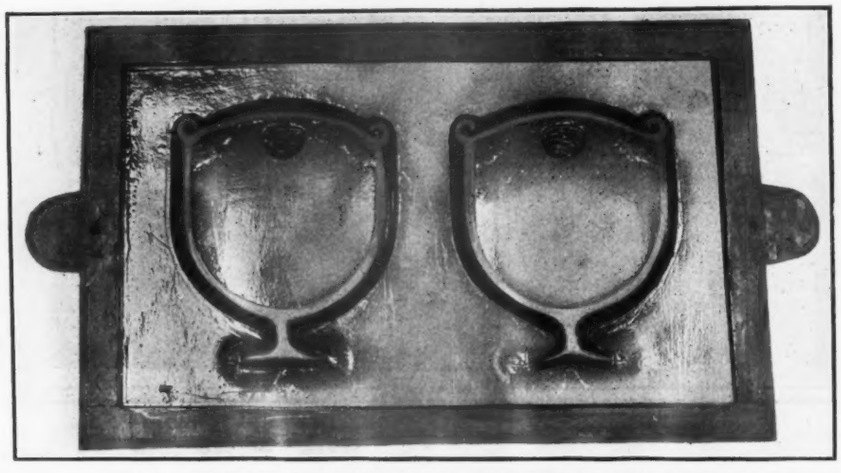


FIG. 5—REVERSE SIDE OF PLASTER MATCH-PLATE IN FRAME

To make these plates the original gated pattern was first molded in a common flask in the ordinary manner. Before the mold was closed, wood strips 5/8 inch thick were nailed on the drag so that the two parts of the flask were separated. The mold was then poured with plaster of Paris, making a plaster match-plate, one side of which is shown in Fig. 4, and the opposite side in Fig. 5. Since 5/8 inch strips are nailed on the drag, the plaster plate was 5/8 inch in thickness. The plate after being taken from the sand and cleaned was varnished with a coat of shellac mixed with lamp-black, making it moisture proof. The edges were then trimmed so that it would fit the cast iron frame shown in Fig. 12. All vertical surfaces on the plaster pattern were trimmed back 3/16 inch to allow for the thick-

ness of the white metal and when finished the plate with the frame appeared as shown in Figs. 4 and 5.

Two separate molds in sand were then made from the framed plate, it being necessary to have a pair of pattern plates for use on the machine. Before the molds were closed a number of small round cores were set to make holes through the castings.

The molds were then poured with cast iron, producing the two plates shown in Figs. 10 and 11. These iron plates serve as a backing for the white metal shell which is cast over the working face of the pattern.

*Method of Attaching White Metal to Plate.*

The white metal is fixed to the iron backing in the following manner: An impression from each side of the original pattern is made in sand and the iron plates are placed over them face down. The iron plates are heated thoroughly and while hot the white metal is poured into the mold from the back through one or more of the cored holes. The shell thus produced is 3/16 inch in thickness because the rabbet or vertical distance from the face of the frame to the face of the plaster pattern, Fig. 4, is 3/16 inch, and also, as previously described, the vertical surfaces of the plaster pattern are trimmed off an equal amount. The white metal fills the holes cored in the plates, thus riveting the facing securely to the iron back. This is shown clearly in Figs. 10 and 11. The iron backing plate being hot when the white metal is poured, shrinks with the latter in cooling. The white metal skin is prevented from excessive shrinkage by the numerous plugs through the iron plate.

In Figs. 4 and 5 the lugs on the frame are shown blank. When the plates are cast they are drilled and pins are inserted in the cope-frame, as shown in Figs. 6 and 7. The flask pins fit through the holes in the lugs on the drag-frame while the pins on the cope-frame engage corresponding holes in lugs on the cope, thus holding the plates firmly to the two portions of the flask. The four holes shown on the edges of the finished plates are for bolting the plates to the table of the molding machine.

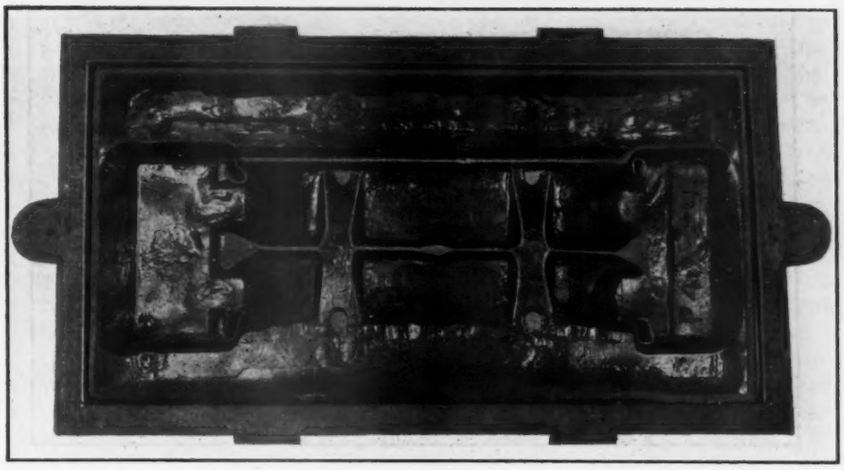


FIG. 8—OBVERSE SIDE OF PLASTER PATTERN FOR A PAIR OF GRATE FRAME PLATES

FIG. 7—DRAG SIDE OF PATTERN PLATE FOR STOVE DOOR CASTINGS

Figs. 3, 8 and 9 show the various stages in the production of a set of pattern plates for a grate frame. The pattern, shown at *B*, Fig. 3, is 14 inches wide and 22 inches long. The plaster of Paris match-plate made from the pattern is shown at *A*, Fig. 3. Figs. 8 and 9 show both sides of the plaster pattern or match-plate in detail. The method of gating this casting is shown clearly in Fig. 3, there being one runner in the center with a split gate feeding the mold on the ends and at four points on each side. The pattern plates for this job were made in the manner previously described.

Fig. 2 shows a pair of plates made for molding the stove top casting illustrated in Fig. 1. These plates are made in an iron frame with white metal facing, the process being exactly similar to that for making the stove doors. The drag plate is shown at the right in Fig. 2, and the cope plate at the left. As indicated in Fig. 1 a split runner is used.

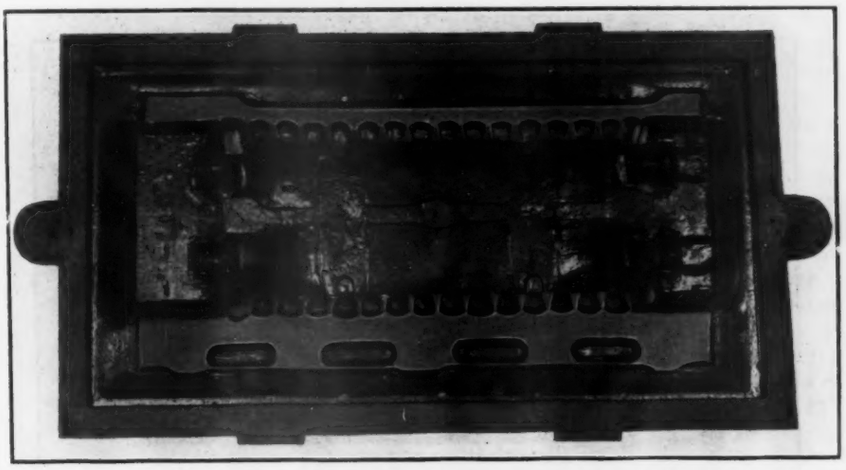


FIG. 9—REVERSE SIDE OF PLASTER PATTERN FOR PAIR OF GRATE FRAME PLATES

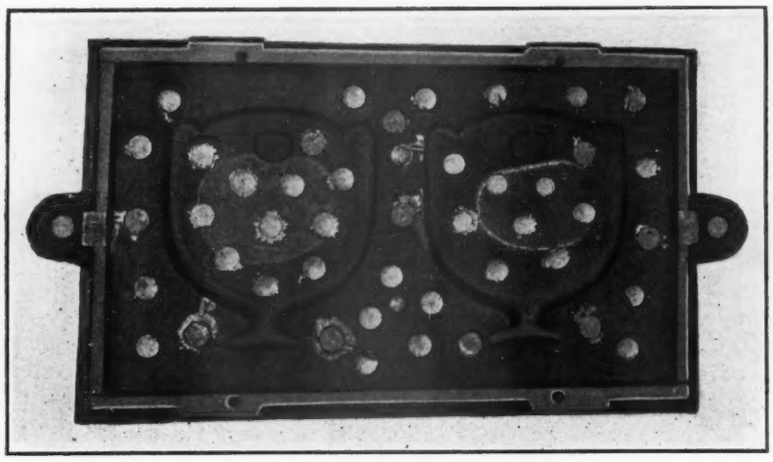


FIG. 10—BACK OF COPE PATTERN PLATE, SHOWING METHOD OF ANCHORING WHITE METAL SHELL

The mold is poured at the center. The runner leads to two eight-point star-shaped gates which connect with the casting as shown at the right in Fig. 2. It will be noted that the gate is greatly restricted at the points where it enters the mold. These necks or orifices are made as small as possible and just back of them the gate is greatly enlarged. When this gate cools the resulting contraction assists in breaking it from the casting. If it does not break off of itself a light blow from a hammer is sufficient to accomplish the desired result.

## Strong Iron Without Steel

*By W. J. Keep*

*Question.*—We have an order for iron castings which should have a tensile strength of 30,000 pounds per square inch. We would like to have a mixture that can be made without steel turnings or borings if possible.

*Answer.*—As you do not give the size of the casting it will be difficult to recommend the silicon content. Presuming, however, that the castings are to be heavy, the silicon should approximate 1.20 to 1.50 per cent. The sulphur should be less than 0.09 per cent; phosphorus less than 0.60 per cent, and manganese, below 0.80 per cent. A casting that will give you this analysis should develop a tensile strength of 25,000 pounds per square inch. Castings of a medium size made from this mixture might be stronger, but would be too hard to machine. You are located in a district where exceedingly strong iron could be obtained at one time. Some brands of this Maryland iron give a tensile strength of 40,000 pounds per square inch. The reason for not desiring to use from 10 to 20 per cent of good steel clippings is not entirely clear, although I would not use turnings or borings. By using steel clippings or other suitable steel scrap, you can, undoubtedly, obtain a tensile strength of 30,000 pounds per square inch, which, at best, must be considered high. I also recommend the use of ½ to 1 per cent of aluminum in the ladle.

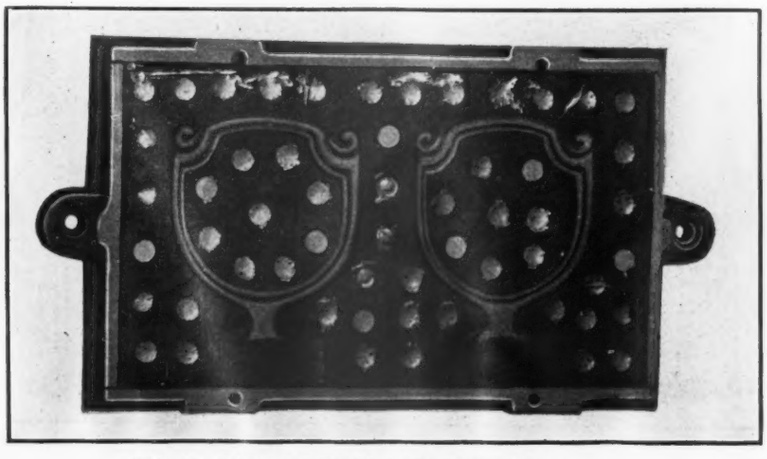


FIG. 11—BACK OF DRAG PATTERN PLATE

## Operating a Cupola

*By W. J. Keep*

*Question:*—What is the effect of too much blast on a cupola and what pressure should be used for a 46-inch furnace? How should the charges be divided to obtain the best results? Our mixtures consist largely of car wheel scrap and pig iron. We are troubled with dull iron and we are compelled to slag off almost throughout the entire heat. The new sand we are using contains a certain percentage of mica and we would like to know whether it is beneficial or harmful.

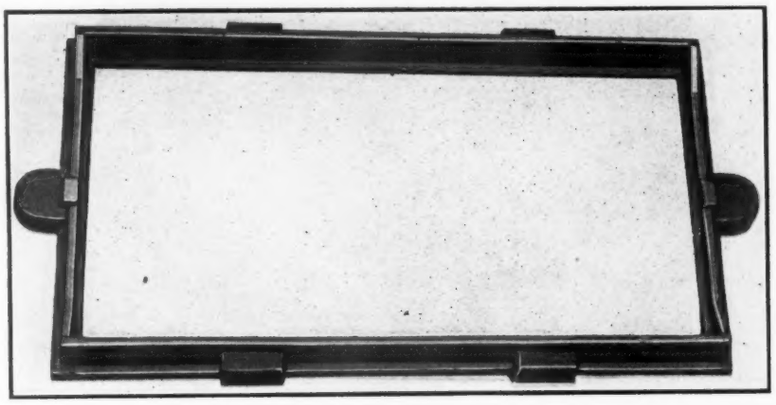


FIG. 12—TYPE OF FRAME IN WHICH PLASTER MATCH-PLATES ARE CAST

*Answer:*—It is necessary to give a cupola a little more air than is theoretically required to burn the coke. A strong blast will not injure the quality of the metal, but it will chill the slag around the tuyeres and if too strong, will cool the cupola so that it will not melt as fast as with a smaller blast pressure. The tuyere openings should never be more than 4 inches high on the inside end. In a 46-inch cupola the tuyeres should be 3½ inches high and 12 inches wide and seven should be installed. The tuyere area will then aggregate 420 square inches. In the back of the cupola over the slag hole, 10 inches of blank space should be provided opposite the spout. This will space

the tuyeres a distance of 7 inches apart. The center of the slag hole should be 4 inches below the lower edge of the tuyere openings in this 10-inch blank space. The distance between the bottom of the tuyeres and the center of the sand bottom should never be less than 12 inches. The blast pressure should be 14 ounces.

The most convenient division of charges for a 46-inch cupola is 2,000 pounds of iron and 200 pounds of coke. If wood is used to light the bed and after it has burned two hours, the top should be 18 inches above the top of the tuyeres.

Break the car wheel scrap to the size of the broken pigs and use sufficient high silicon iron to reduce the chill to meet your requirements. If you work close to these suggestions you will have hot iron. It is advisable to let the slag run throughout the entire heat and 20 pounds of limestone, or more if necessary, should be added to each charge of coke.

The best molding sands contain considerable mica. The grains of good sand should be as angular as possible and should not be worn smooth the same as the grains of river sand. It should contain a sufficient amount of loam for a bond. The sand should be yellowish brown, but if darker, it is liable to contain too much iron for satisfactory use. If the sand has a bluish tint it will be found to contain lime. The adaptability of sand to various kinds of work depends on the size of its grains and on its bond.

# Mottled Malleable Iron

By Walter E. Riepen

DIFFICULTIES resulting in mottled iron were discussed on page 132 of the April issue of THE FOUNDRY. The high percentage of phosphorus was assigned as the cause of this phenomenon. The writer obtained samples of these malleable castings, one hard iron and two samples of annealed iron. These samples analyzed as follows:

Hard iron.—Silicon, 1.07 per cent; sulphur, 0.065 per cent; phosphorus, 0.624 per cent; manganese, 0.33 per cent; combined carbon, 1.60 per cent; graphitic carbon, 0.83 per cent, and total carbon, 2.43 per cent.

Annealed iron No. 1.—Silicon, 1.12 per cent; sulphur, 0.072 per cent; phosphorus, 0.438 per cent; manganese, 0.30 per cent; combined carbon, trace, and graphitic carbon, 0.74.

Annealed iron No. 2.—Silicon, 0.71 per cent; sulphur, 0.064 per cent; phosphorus, 0.232 per cent; manganese, 0.35 per cent; combined carbon, trace, and graphitic carbon, 2.40 per cent.

A microscopical examination of the hard iron showed that the mottled appearance was due to free carbon in the form of graphite which was in layers. Only one condition would permit the graphite to form in layers. The carbon would have to be in the free graphitic condition while some portion of the iron was still either molten or in a pasty form. When cooling, the graphite was squeezed into layers by the shrinkage of the iron. An excellent example of this action is found in any pig iron in which the silicon is sufficiently high to permit of the separation of graphite. The latter will be found in the form of layers in iron of this kind. When iron containing a large amount of combined carbon is annealed the temperature is not raised high enough to permit the precipitated graphite to form into layers and it is, therefore, found in small, isolated, rounded areas. It is evident, therefore, that the hard iron from which the sample was taken was drawn from the furnace while the carbon was still in excess of the amount with which the iron could combine. This graphite then separated out in time for the shrinking action of the cooling metal to press it into the layers in which form it was found in the sample.

### *Saturation Point For Carbon*

The saturation point for carbon is governed by the other elements present. Both silicon and phosphorus lower this saturation point while sulphur increases it. In other words, silicon and phosphorus lower the amount of carbon which can exist combined with the iron. It was for this reason that it was found impossible to prevent the carbon from separating out in the particular mixture used and a close study of the analysis of this sample will show that the carbon is very low for good malleable iron and lower than it would be if the percentage of silicon and phosphorus were less.

If it is desirable to continue to maintain the phosphorus at approximately 0.60 per cent, it would be found advisable to lower the silicon until the saturation point of the iron for carbon increased to approximately 2.75 per cent. With this high phosphorus it would be necessary to have the carbon in the mixture before melting, not over 3.50 per cent and care would have to be exercised in firing the furnace so that the iron would be hot enough to pour light work before the silicon had decreased much below 0.75 per cent. For this purpose the coal used for fuel should contain not less than 35 per cent volatile carbon and the smoky flame should be carried until the stock is thoroughly melted. The oxidizing flame should only be utilized when the bath is skimmed. By following these suggestions it would be possible to run a high phosphorus mixture and to raise the saturation point to approximately 2.75 per cent, where it should be.

### *Annealing the Iron*

Unless these recommendations are followed closely, trouble will be experienced in the annealing process and the tendency will be to overanneal, as was the case with the sample of annealed iron submitted. This had the white appearance of the steel fracture. The specimen contained only 0.74 per cent graphitic carbon, whereas the carbon should not be less than 1.50 per cent for first class malleable. It is possible to anneal a low carbon iron, even if it is the result of high phosphorus, so as to have the carbon as high as 1.60 to 1.80 per cent in the castings, but it requires a very careful adjustment of the annealing temperatures. The writer has annealed iron with carbon as low as 2.10 per cent in the hard and has obtained castings from annealing ovens containing 1.80 per cent of graphitic carbon.

The cause of the mottled appearance is due to the fact that the iron was not held in the furnace long enough to burn out the carbon in excess of the saturation point and this condition was brought about by the high phosphorus present. If the iron had been permitted to remain in the furnace for a longer period, thereby lowering the carbon, a good deal of trouble would probably have been experienced with mis-run castings, as the writer does not believe this tendency would have been entirely overcome with the phosphorus around 0.60 per cent, although this would make the iron more fluid. While low carbon iron seems to be hot enough for all practical purposes, when the metal is drawn from the furnace it soon dies down and becomes very sluggish even before it is poured into the molds. For this reason the percentage of mis-run castings will be high. The sample of annealed iron containing 2.40 carbon was drawn from the annealing oven too soon.

# The Results of a Series of Chillable Iron Tests*

## *Experiments With Car Wheel and Alloyed Irons to Ascertain Their Chilling Properties—Round and Square Test Bars Compared*

By Thomas D West

A SERIES of tests of chillable irons, made during the period from September, 1911, to the close of February, 1912, are presented in this paper. Before proceeding with the tests it was desired to find what size of bar should be used with different grades of iron to produce a bar of all gray iron and at the same time a companion bar that could be wholly chilled, both having been poured from the same ladle. Tests of two sets of bars indicated that those 1⅝ inches in diameter are suitable for various grades of chillable metal having silicon ranging from 0.90 to 1.20 per cent. The balance of the sets showed that 2¼-inch bars are suitable for many grades of iron having a range of 0.50 to 0.90 per cent silicon. The constituents of these bars, other than silicon, are the same as in such castings as chilled car wheels and rolls. In some cases the larger bars may be used for higher silicon metal, this depending chiefly upon the metal being high in sulphur and without ferro-manganese addition.

While the round bar is advocated as a standard, there are cases of experimental work, such as presented in this paper, where square bars may be advisable, but for ordinary practice, to obtain comparisons of mixtures, grades of metal, etc., the round bars are preferred. For molding the square bars three flasks were used, each adapted for casting three or four bars. These bars were 2 inches square by 24 inches long. For casting the round bars, two chill molds having a bore of 1⅝ inches, bored out to 25-16 inches, were used in connection with two pipe sand molds.

The bars for these tests were poured from the regular metal from a reservoir ladle, with a capacity of about 7 tons, and the iron was carried to the molds in a ladle which held about 250 pounds. Twelve ounces of ferro-manganese were thrown into the ladle to secure the same composition as used for car wheels in which 2 to 2½ pounds of ferro-manganese are added to every 700 or 800 pounds of metal. After the bars were poured with this regular wheel metal the ladle was filled as often as needed and vanadium or titanium, or both together, were added with the 12 ounces of manganese, according to the tests to be made. The ladle was allowed to stand for three or four minutes to permit the alloys to melt thoroughly and to mix with the metal. A ½-inch rod was used to agitate the metal to help bring any oxides created by the alloys to its surface. The ladles of metal required for a set of bars were filled from the reservoir ladle before any additional metal was run into it from the cupola. Both round and square bars were cast.

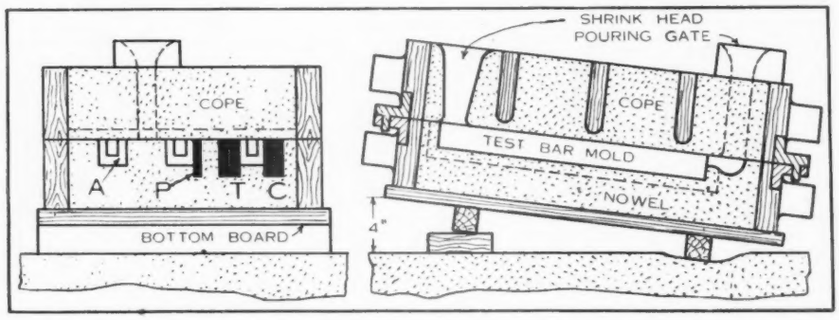



FIG. 1—SECTIONAL VIEW OF MOLD FOR MAKING SQUARE TEST BARS

Some of the square test bars were cast with a 2 x 2½-inch chiller on two sides, as illustrated at *TC* in the end view of Fig. 1. This was done to chill the bar to produce white iron. Others had a wrought plate, ¼ or ½ inch thick on one side of the bar only, as at *P*, to chill partly one side of the bar. Bars free from chill were surrounded with sand as shown at *A*. In some cases two totally chilled bars and one all gray bar were cast in the same flask.

The character of the chill, or grain of iron, is given in the accompanying tables under the heading, *Fracture*. An all-sand molded bar that showed a slightly mottled fracture instead of all-gray is termed *slightly mottled*. If the fracture was deeply mottled it is so indicated. In cases where the depth of a partly chilled bar was measured, the thickness of the chill is given in connection with the statement that one side was chilled.

To indicate that one of the vertically-cast sides, the cope surface, or the nowel face of a bar was in tension when tested, the words *nowel, cope* and *side* are placed on the line with the respective bar in the column headed *Tension*. This will be better understood by referring to Fig. 2, which illustrates the two methods of testing the bars.

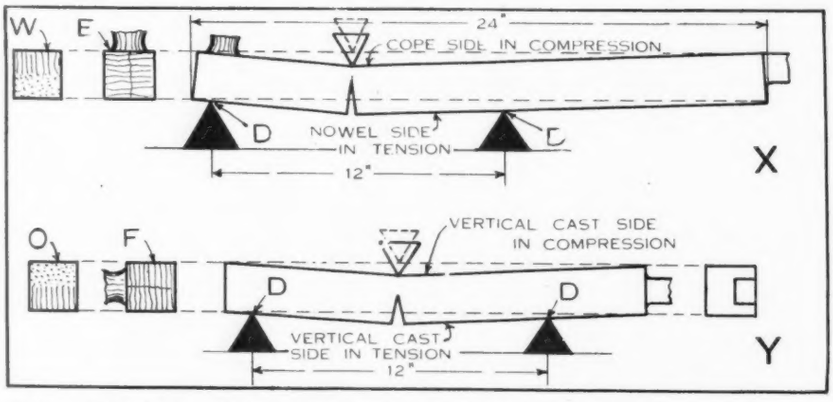



FIG. 2—END AND SIDE VIEWS OF A TEST BAR MADE IN MOLD, FIG. 1, AT *X*; *Y* SHOWS THE SECOND TEST ON A 2-INCH SQUARE BAR

*Presented at the Cleveland meeting of the American Society of Mechanical Engineers.

The width and depth as well as the diameter of all the tested bars are given in Tables III to X to permit checking the modulus of rupture column. The records of all tests are of solid bars and complete fractures.

**Table I.**
RANGE OF CHEMICAL CONSTITUENTS OF CHILLED CAR WHEELS

| | Per cent. |
|---|---|
| Silicon | 0.55 to 0.65 |
| Sulphur | 0.10 to 0.15 |
| Manganese | 0.55 to 0.70 |
| Phosphorus | 0.27 to 0.32 |
| Combined carbon | 0.60 to 0.70 |
| Graphitic carbon | 2.70 to 2.90 |

All transverse tests on both round and square bars, Tables V to IX, except tests 59 and 77, were made with a 12-inch span, and all drop tests in Table XII, with an 8-inch span; all others were tested for the transverse and drop tests on a 12-inch span, as shown in Fig. 2. Tests 59 and 77 were made with a 10-inch span. All drop tests in Tables V to IX were made with a 12-inch span.

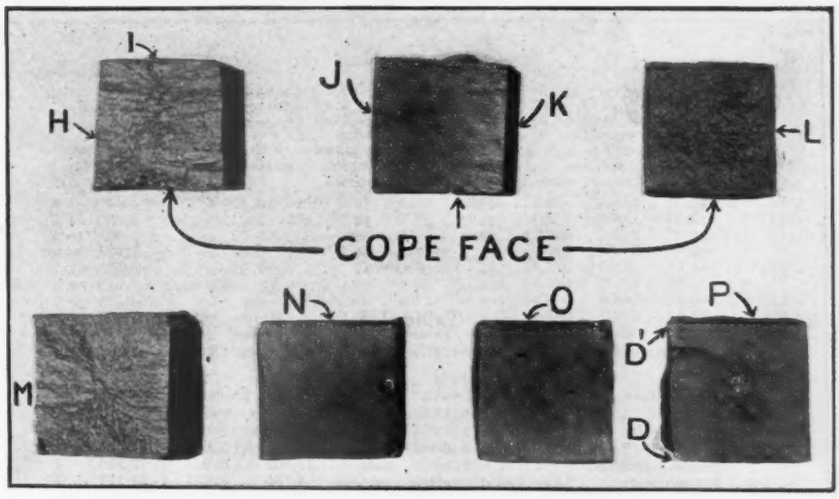



FIG. 4—TOP ROW: SET OF SQUARE BARS CAST FLAT; BOTTOM ROW: SET OF SQUARE BARS CAST ON END

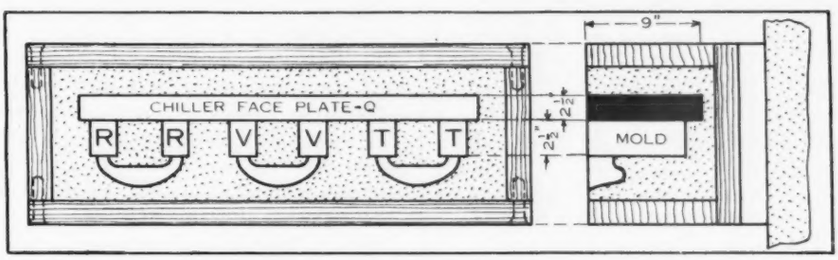



FIG. 3—OPEN SAND MOLD FOR MAKING COMPARATIVE CHILLING TESTS

The drop tests were made with a 25-pound weight, having the first drop at a height of 6 inches and raised 6 inches higher for every blow until the bar was broken. If, for example, 6 is the number in the *drop* column of the tables, it means that the weight dropped once at each of the respective heights, 6, 12, 18, 24, 30 and 36 inches, before breaking the bar. The bars for the drop tests, Tables V to IX, were obtained by taking the long end of the 24-inch, square bars after they had been subjected to one transverse test. For this reason two kinds of tests with the same bar are given under the same test number.

A comparison of the drop tests with the transverse tests shows that where a bar is strong transversely it generally shows a relatively high strength under the drop test. This was also true in the case of nearly all of the round bars having a 6-inch span.

For castings subjected to shock or sudden impact, such as car wheels, rolls, shears, dies, etc., the drop test should grow in favor. The apparatus is not expensive and the time required is less than that consumed by any other method of testing.

No special, complete analysis is given of the respective sets other than that in Table I. This is due to the fact that car wheel mixtures used in one foundry vary but little. Table II gives the vanadium and titanium constituents of the test bars. Analyses of metal taken directly from the reservoir ladle **before** the ferro-manganese was added showed that this iron contained approximately 0.40 per cent manganese. The drillings for regular car wheel metal analyses are taken from blocks about 2 x 2½ x 8 inches, cast in sand so as to leave a gray body in the metal, which will agree closely with the gray iron between the plate and body, back of the chill of a car wheel.

Table III shows that bars, 1¼ inches square and 1⅝ inches round are too small for regular car wheel metal. This is indicated by the all-sand bars 3, 5, 8, 10 and 12, which showed fractures too strongly mottled instead of a fair gray structure. These sizes of bars are recommended only for chillable irons ranging from 0.90 to 1.20 per cent silicon.

The foregoing is a general statement, requiring modifications in some instances. A comparison of the strength of bars 4, 5, 11 and 12 with 9 and 10 indicates that strongly mottled iron of

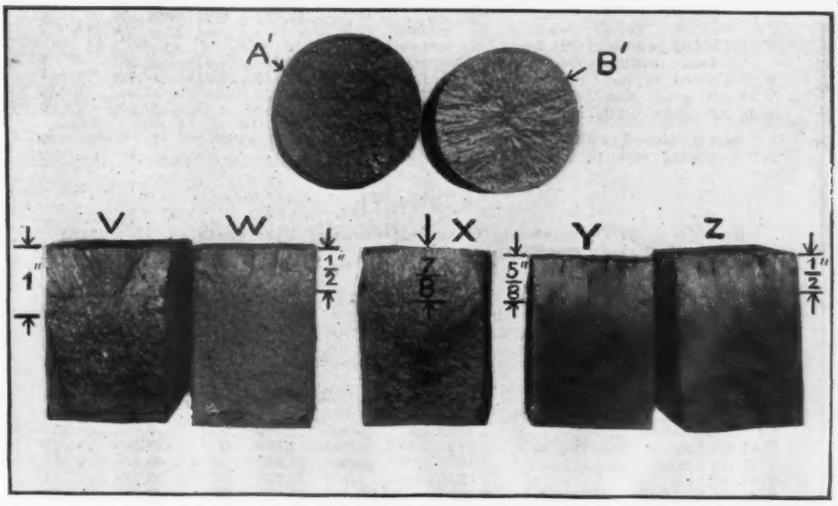



FIG. 5—TOP ROW: SET OF ROUND BARS CAST ON END; BOTTOM ROW: AFFECTS OF COOLING AND VARYING PERCENTAGES OF VANADIUM AND TITANIUM ON SQUARE TEST BARS

### Table II.

ANALYSIS OF SETS ALLOYED WITH VANADIUM AND TITANIUM

| Set No. | Ounces vanadium in 225 pounds of metal. | Ounces of titanium in 225 pounds of metal. | Per cent of vanadium in test bars. | Per cent of titanium in test bars. | Per cent of manganese in test bars. |
|---|---|---|---|---|---|
| 9 | 10 | .. | 0.06 | .... | 0.63 |
| 11 | .. | 10 | .... | 0.02 | 0.72 |
| 13 | 22 | .. | 0.12 | .... | 0.64 |
| 15 | .. | 22 | .... | 0.37 | 0.60 |
| 18 | 5 | 10 | 0.04 | 0.03 | 0.69 |
| 19 | 8 | 15 | 0.05 | 0.05 | 0.68 |

### Table III.

TRANSVERSE TESTS 1¾ INCHES SQUARE AND 1⅝-INCH ROUND BARS

| Test No. | Fracture. | Width, inches. | Depth, inches. | Tension | Maximum load, pounds. | Deflection, inches. | Modulus of rupture | Set No. |
|---|---|---|---|---|---|---|---|---|
| 1 | All white | 1.73 | 1.72 | Nowel | 5,140 | 0.016 | 18,070 | 1 |
| 2 | All white | 1.68 | 1.69 | Side | 13,160 | 0.028 | 49,380 | 1 |
| 3 | Slightly mottled | 1.75 | 1.76 | Side | 15,300 | 0.060 | 50,820 | 1 |
| 4 | All white | 1.59 | diameter | .... | 4,780 | 0.023 | 36,280 | 1 |
| 5 | Slightly mottled | 1.60 | diameter | .... | 7,340 | 0.065 | 54,670 | 1 |
| 6 | All white | 1.69 | 1.69 | Nowel | 7,580 | 0.028 | 28,260 | 2 |
| 7 | All white | 1.71 | 1.71 | Side | 15,280 | 0.042 | 55,010 | 2 |
| 8 | Strongly mottled | 1.72 | 1.79 | Side | 11,940 | 0.038 | 39,000 | 2 |
| 9 | All white | 1.60 | diameter | .... | 5,820 | 0.032 | 43,350 | 2 |
| 10 | Almost white | 1.56 | diameter | .... | 5,540 | 0.040 | 44,520 | 2 |
| 11 | All white | 1.59 | diameter | .... | 3,080 | 0.021 | 23,370 | 3 |
| 12 | Strongly mottled | 1.58 | diameter | .... | 7,760 | 0.073 | 60,030 | 3 |

### Table IV.

TRANSVERSE TESTS OF VARIABLE DEPTHS OF CHILL WITH LOW CHILLING IRONS

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Load, pounds. | Deflection, inches. | Modulus of rupture. | Set No. |
|---|---|---|---|---|---|---|---|
| 13 | Not chilled; clear gray iron..... | 1.01 | 1.51 | 5,615 | 0.098 | 43,900 | 4 |
| 14 | Chilled one side; 10 per cent white.. | 1.00 | 1.50 | 4,360 | 0.085 | 34,900 | 4 |
| 15 | Chilled two sides; 25 per cent white | 0.96 | 1.44 | 3,270 | 0.056 | 29,600 | 4 |
| 16 | Not chilled; clear gray iron..... | 0.98 | 1.46 | 5,175 | 0.105 | 44,500 | 5 |
| 17 | Chilled one side; 15 per cent white. | 1.03 | 1.48 | 4,220 | 0.069 | 33,700 | 5 |
| 18 | Chilled two sides; 20 per cent white | 1.02 | 1.45 | 4,390 | 0.079 | 36,900 | 5 |
| 19 | Not chilled; clear gray iron..... | 0.97 | 1.47 | 5,000 | 0.103 | 43,000 | 6 |
| 20 | Chilled one side; 1 per cent white.. | 1.00 | 1.47 | 5,610 | 0.108 | 46,750 | 6 |
| 21 | Chilled two sides; 100 per cent white | 1.01 | 1.47 | 6,400 | 0.080 | 52,800 | 6 |
| 22 | Not chilled; clear gray iron..... | 1.00 | 1.46 | 4,350 | 0.157 | 36,700 | 7 |
| 23 | Chilled one side; 5 per cent white. | 0.99 | 1.43 | 4,550 | 0.159 | 40,500 | 7 |
| 24 | Chilled one side; 20 per cent white. | 1.06 | 1.50 | 4,200 | 0.137 | 31,700 | 7 |
| 25 | Chilled two sides; 50 per cent white | 1.02 | 1.50 | 2,300 | 0.110 | 18,050 | 7 |

### Table V.

BARS 26 TO 30 CONTAINED 12 OUNCES MANGANESE; 31 TO 34, 12 OUNCES MANGANESE AND 10 OUNCES VANADIUM IN 225 POUNDS OF METAL

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Tension. | Load, pounds. | Deflection, inches. | Modulus of rupture | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|---|
| R 26 | Chilled both sides, all white iron ..... | 2.04 | 2.00 | nowel | 15,150 | 0.030 | 33,420 | 4 | 8 |
| R 27 | Chilled ¼ inch one side.. | 2.10 | 2.05 | nowel | 14,330 | 0.036 | 29,230 | 6 | 8 |
| R 28 | All gray iron..... | 2.12 | 2.08 | nowel | 23,860 | 0.070 | 46,820 | 9 | 8 |
| R 29 | All gray iron..... | 2.31 | diameter | .... | 25,750 | 0.095 | 63,710 | . | 8 |
| R 30 | Chilled; all white iron.... | 2.21 | diameter | .... | 14,620 | 0.030 | 41,330 | . | 8 |
| V 31 | Chilled two sides; all white iron ..... | 2.08 | 1.97 | nowel | 16,100 | 0.030 | 35,900 | 4 | 9 |
| V 32 | Chilled ⅜ inch one side.. | 2.05 | 1.99 | nowel | 15,370 | 0.035 | 34,380 | 5 | 9 |
| V 33 | All gray iron..... | 2.08 | 2.00 | nowel | 22,020 | 0.070 | 47,640 | 9 | 9 |
| V 34 | All gray iron..... | 2.32 | diameter | .... | 23,430 | 0.070 | 57,300 | . | 9 |

Set R poured with regular iron. Set V poured with vanadium in regular iron. Set T poured with titanium in regular iron.

### Table VI.

BARS 33 TO 39 CONTAINED 12 OUNCES MANGANESE; BARS 40 TO 44, 12 OUNCES MANGANESE AND 10 OUNCES TITANIUM IN 225 POUNDS OF METAL

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Tension. | Load, pounds. | Deflection, inches. | Modulus of rupture | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|---|
| R 35 | Chilled both sides; all white | 2.14 | 1.98 | nowel | 22,420 | ..... | 48,108 | . | 10 |
| R 36 | Chilled ⅛ inch one side.. | 2.03 | 2.07 | nowel | 18,990 | 0.037 | 39,170 | 3 | 10 |
| R 37 | All gray iron..... | 2.12 | 2.04 | nowel | 25,740 | 0.075 | 54,700 | 11 | 10 |
| R 38 | All gray iron..... | 2.27 | diameter | .... | 25,520 | 0.077 | 66,570 | . | 10 |
| R 39 | Chilled; all white iron... | 2.22 | diameter | .... | 13,440 | 0.024 | 37,477 | . | 10 |
| T 40 | Chilled both sides; all white ..... | 2.02 | 1.97 | nowel | 16,100 | 0.031 | 36,960 | 4 | 11 |
| T 41 | Chilled ¾ inch one side.. | 2.07 | 2.00 | nowel | 15,130 | 0.032 | 33,280 | 5 | 11 |
| T 42 | All gray iron..... | 2.06 | 1.99 | nowel | 21,870 | 0.074 | 48,250 | 9 | 11 |
| T 43 | All gray iron..... | 2.32 | diameter | .... | 23,400 | 0.059 | 57,180 | . | 11 |
| T 44 | Chilled; all white iron..... | 2.22 | diameter | .... | 17,110 | 0.028 | 47,711 | . | 11 |

the same metal, also iron tending to all-white, as No. 10, will give exceptional strength. Many other round bars, 1⅝ inches in diameter were made, but were broken with a sledge to check the fractures. The two odd bars, 11 and 12, display greatly contrasting properties.

When a bar is of such a size that it is inclined to assume a mottled form, it is liable to go further and to become almost white; with the same iron, same temperature of metal and mold, there is as much chance to obtain a strength of 7,760 pounds as 5,540 pounds, as indicated by bars 10 and 12. But this sensitive condition must be avoided to make better comparisons between an all-chilled bar and an all-sand cast bar of the same size, form, and metal. To do this, it is necessary to have the sand cast bars sufficiently large to prevent their taking a mottled form, and still not so large as to prevent their being absolutely chilled to their centers, when cast in an all-iron mold or chiller. Many experiments may often be necessary to ascertain the best size to adopt for making a comparison between the white and gray of special chillable irons. Some of the 2¼-inch round bars were slightly mottled, although their silicon content was approximately 0.60 per cent. This could have been avoided largely by baking or drying the sand molds, as those used in the tests outlined were green sand. To increase the size of the round bar would reduce the tendency toward mottling. These could be made 2¾ and possibly 3 inches in diameter and still produce a perfect, all-chilled bar as a companion to an all-sand cast or gray bar having silicon around 0.60 per cent.

### *Erratic Effects of Chilled Crystals*

It is important, therefore, to describe the structure of fractures when recording tests of chillable iron and when making comparisons with all-chilled and gray bars. It all shows that in some cases, it may be necessary to experiment in order to obtain the diameter best suited to ascertain the relative strength of the white and gray of chillable irons. This does not prevent the adoption of a standard for tests of chillable irons. All that is necessary is to state the structure of the fracture, diameter of the bar used, per cent of silicon, and possibly other constituents, if they vary to any extent from those given in Table I.

Table IV presents a few of the many tests made with chillable metal having about the following composition: Silicon, 2 per cent; sulphur, 0.06 per cent; phosphorus, 0.04 per cent and manganese, 0.30 per cent. In testing this set the load was applied in the deep direc-

tion of the bars, which were all cast on end. Tests Nos. 13 to 25 illustrate the erratic qualities of partly chilled bodies, caused by the interlacing of the white with the gray and the depth of mottled iron back of the chilled body.

In partly chilled sections, the temperature of the chiller to chill the iron, and of the metal to pour the mold, and the degree of dampness in the sand, have an effect both on the depth of chill, and on the structure of the metal for a considerable distance beyond the place where the white iron ceases. These are all factors difficult to control in regular practice, but the more that is known concerning them, the better will be the design of the castings. The variable hardness of mottled and gray bodies, interlacing with the white iron of chilled bodies, are displayed by the hardness tests, Table XI.

### *Tests of Bars Alloyed With Vanadium and Titanium*

Tables V to IX present a series of tests comprising the following features:

Comparison of strength, deflection, chill and contraction, in all-chilled, partly-chilled, and gray bars of the same metal.

Comparison of square and round bars to emphasize the utility of the latter as a standard.

Comparisons of transverse and drop tests to show their conformity, and the practicability of the latter.

Comparisons of hardness created by the rate in cooling, giving chilled, mottled and gray fractures in the same metal.

Effects of ferro-manganese, vanadium, and titanium in the same metal and size of section, when of a chilled, mottled and gray structure.

It will be noted in Table XII that when the chilled face is in tension, as in tests Nos. 92, 94 and 96, the casting is much weaker than when the gray or mottled body is in tension, as in tests Nos. 91, 93 and 95 of set No. 22. The reliability of this set of tests will be appreciated when it is understood that the respective companion tests having the chilled side in compression and tension were made with the same bar, by the method shown in Fig. 2. After making two transverse tests of the same bar, there was sufficient remaining for a drop test having an 8-inch span. A few of these tests are indicated in Nos. 83 to 96. Bars 83 to 90 were cast on end, while bars 91 to 96 were cast flat, as shown in Fig. 1, and chilled on one side. The lower row, Fig. 5, shows a full set of the square bars cast on end, in which *M* is the all-chilled bar, *N* the

## Table VII.

BARS 45 TO 49 CONTAINED 12 OUNCES MANGANESE; BARS 50 TO 54, 12 OUNCES MANGANESE AND 22 OUNCES VANADIUM IN 225 POUNDS OF METAL

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Tension. | Load, pounds. | Deflection, inches. | Modulus of rupture | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|---|
| R 45 | Chilled both sides; all white | 1.90 | 2.02 | nowel | 16,460 | 0.030 | 38,220 | 5 | 12 |
| R 46 | Chilled 3/8 inch one side.. | 2.10 | 2.00 | nowel | 14,380 | 0.035 | 30,810 | 7 | 12 |
| R 47 | All gray iron..... | 2.08 | 2.01 | nowel | 23,700 | 0.090 | 50,960 | 11 | 12 |
| R 48 | All gray iron..... | 2.29 | diameter | .... | 23,910 | 0.078 | 60,730 | . | 12 |
| 49 | Chilled; all white iron.... | 2.22 | diameter | .... | 15,610 | 0.022 | 43,520 | . | 12 |
| V 50 | Chilled both sides; all white | 2.00 | 1.98 | nowel | 16,030 | 0.035 | 36,800 | 4 | 13 |
| V 51 | Chilled 7/8 inch one side.. | 2.10 | 2.02 | nowel | 14,090 | 0.030 | 29,600 | 3 | 13 |
| V 52 | Gray, slightly mottled.... | 2.05 | 2.00 | nowel | 24,800 | 0.065 | 54,440 | 7 | 13 |
| V 53 | Gray, slightly mottled ... | 2.27 | diameter | .... | 25,580 | 0.060 | 66,710 | . | 13 |
| V 54 | Chilled; all white iron.... | 2.20 | diameter | .... | 17,890 | 0.025 | 51,250 | . | 13 |

## Table VIII.

BARS 55 TO 59 CONTAINED 12 OUNCES MANGANESE; BARS 60 TO 64, 12 OUNCES MANGANESE AND 22 OUNCES TITANIUM IN 225 POUNDS OF METAL. BARS 65 TO 68 WERE FREE FROM MANGANESE AND OTHER ALLOYS

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Tension. | Load, pounds. | Deflection, inches. | Modulus of rupture | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|---|
| R 55 | Chilled both sides; all white | 2.00 | 2.00 | nowel | 15,980 | 0.030 | 35,960 | 4 | 14 |
| R 56 | Chilled 3/8 inch one side; balance mottled ..... | 2.00 | 2.07 | nowel | 18,140 | 0.038 | 38,100 | 4 | 14 |
| R 57 | Gray iron; corners chilled. | 2.02 | 2.00 | nowel | 22,720 | 0.070 | 50,610 | 7 | 14 |
| R 58 | Gray iron, slightly mottled | 2.25 | diameter | .... | 26,000 | 0.075 | 69,640 | . | 14 |
| 59 | Chilled; all white..... | 2.24 | diameter | .... | 13,830 | 0.017 | 33,966 | . | 14 |
| T 60 | Chilled both sides; all white | 2.00 | 1.98 | nowel | 13,200 | 0.025 | 30,300 | 4 | 15 |
| T 61 | Chilled 1/2 inch one side; balance mottled ..... | 2.04 | 2.03 | nowel | 16,840 | 0.035 | 36,060 | 4 | 15 |
| T 62 | Gray, corners slightly chilled | 2.05 | 2.00 | nowel | 22,080 | 0.075 | 48,470 | 10 | 15 |
| T 63 | Gray iron ..... | 2.26 | diameter | .... | 25,810 | 0.08 | 68,230 | . | 15 |
| T 64 | Chilled; all white iron.... | 2.22 | .... | .... | 16,070 | 0.05 | 44,810 | . | 15 |
| S 65 | Chilled both sides; all white | 2.04 | 2.04 | nowel | 11,400 | 0.020 | 24,170 | 3 | 16 |
| S 66 | Chilled 5/8 inch one side; deeply mottled ..... | 2.06 | 2.04 | nowel | 10,860 | 0.030 | 22,800 | 3 | 16 |
| S 67 | Gray, corners mottled..... | 2.04 | 2.00 | nowel | 17,870 | 0.050 | 39,420 | 5 | 16 |
| S 68 | Gray iron, mottled..... | 2.25 | diameter | .... | 24,180 | 0.065 | 64,204 | . | 16 |

Set S poured with spurious metal, containing no ferro-manganese.

## Table IX.

BARS 69 TO 72 CONTAINED 12 OUNCES MANGANESE; BARS 73 TO 77, 10 OUNCES TITANIUM AND 5 OUNCES VANADIUM; BARS 78 TO 82, 12 OUNCES MANGANESE, 15 OUNCES TITANIUM AND 8 OUNCES VANADIUM IN 225 POUNDS OF METAL

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Tension. | Load, pounds. | Deflection, inches. | Modulus of rupture | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|---|
| R 69 | Chilled both sides; all white | 1.98 | 2.02 | nowel | 18,480 | 0.035 | 41,170 | 5 | 17 |
| R 70 | Chilled 1/4 inch one side; balance mottled ..... | 2.04 | 2.50 | nowel | 16,760 | 0.055 | 23,660 | 6 | 17 |
| R 71 | All gray iron..... | 2.05 | 2.05 | nowel | 24,390 | 0.085 | 51,020 | 11 | 17 |
| R 72 | All gray iron..... | 2.27 | diameter | .... | 24,030 | 0.065 | 62,660 | . | 17 |
| TV 73 | Chilled both sides; all white ..... | 2.02 | 2.00 | nowel | 12,330 | 0.025 | 27,470 | . | 18 |
| TV 74 | Chilled 1/8 inch one side; balance mottled ..... | 2.05 | 2.07 | nowel | 18,340 | 0.040 | 37,580 | 6 | 18 |
| TV 75 | All gray iron ..... | 2.10 | 2.04 | nowel | 24,980 | 0.065 | 51,390 | 11 | 18 |
| TV 76 | All gray iron ..... | 2.29 | diameter | .... | 22,070 | 0.060 | 56,060 | . | 18 |
| TV 77 | Chilled; all white iron.. | 2.21 | diameter | .... | 16,370 | 0.029 | 38,560 | . | 18 |
| TV 78 | Chilled both sides; all white ..... | 1.96 | 2.03 | nowel | 16,250 | 0.030 | 36,210 | 4 | 19 |
| TV 79 | Chilled 1/4 inch one side; balance mottled ..... | 2.00 | 2.04 | nowel | 14,580 | 0.040 | 31,530 | 5 | 19 |
| TV 80 | All gray iron ..... | 2.04 | 2.00 | nowel | 22,240 | 0.065 | 49,060 | 8 | 19 |
| TV 81 | All gray iron ..... | 2.29 | diameter | .... | 23,470 | 0.060 | 59,620 | . | 19 |
| TV 82 | Chilled; all white iron.. | 2.20 | diameter | .... | 18,700 | 0.030 | 53,570 | . | 19 |

Set S poured with spurious metal, containing no ferro-manganese.

## Table X.

CONTRACTION, IN INCHES, OF ROUND BARS CAST ON END AND SQUARE BARS CAST FLAT

| Set No. | Round bars, all chilled. | Round bars, all gray. | Square bars, all chilled. | Square bars, part chilled. | Square bars, all gray. |
|---|---|---|---|---|---|
| R 12 | 0.22 | 0.12 | 0.47 | 0.28 | 0.26 |
| V 13 | 0.23 | 0.13 | 0.48 | 0.30 | 0.27 |
| R 14 | 0.22 | 0.12 | 0.47 | 0.28 | 0.26 |
| T 15 | 0.21 | 0.11 | 0.43 | 0.29 | 0.25 |
| S 16 | .... | .... | 0.50 | 0.36 | 0.32 |
| R 17 | .... | .... | 0.48 | 0.31 | 0.28 |
| TV 18 | 0.22 | 0.12 | 0.47 | 0.29 | 0.26 |
| TV 19 | 0.23 | 0.12 | 0.48 | 0.30 | 0.27 |

## Table XI.

BRINELL AND SCLEROSCOPE HARDNESS TESTS OF SPECIMENS, FIG. 4

| | | —H— | | —I— | | —J— | | —K— | | —L— | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Set No. | Class. | Bri. | Scl. | Bri. | Scl. | Bri. | Scl. | Bri. | Scl. | Bri. | Scl. |
| 12 | R | 394 | 65 | 348 | 59 | 179 | 39 | 326 | 55 | 185 | 39 |
| 13 | V | 377 | 63 | 358 | 60 | 227 | 41 | 403 | 60 | 199 | 41 |
| 14 | R | 417 | 66 | 403 | 58 | 185 | 38 | 386 | 61 | 175 | 38 |
| 15 | T | 419 | 68 | 427 | 56 | 211 | 41 | 412 | 58 | 186 | 40 |
| 16 | S | 452 | 69 | 412 | 59 | 224 | 40 | 443 | 60 | 191 | 42 |
| 17 | R | 358 | 62 | 390 | 56 | 189 | 39 | 317 | 47 | 173 | 37 |
| 18 | TV | 382 | 64 | 375 | 61 | 193 | 40 | 400 | 54 | 183 | 40 |
| 19 | TV | 442 | 66 | 422 | 54 | 189 | 41 | 417 | 57 | 179 | 38 |

chilled side, and *O* the gray side of the partly chilled bars, while *P* is the all-sand cast bar. The position of the chilled face when testing is shown at *W* for both the end cast and flat cast bars when upward, and at *O* when downward, at the left of Fig. 2.

Another feature is the great difference between the strength of chilled iron when the lines of crystallization are vertical to the load, and when they are horizontal to it. In Table III, tests Nos. 1, 2, 6 and 7 show a difference of about 61 per cent for the first two bars, and about 51 per cent for the second two. The lines of crystallization are shown in Fig. 2, *E* being the weakest and *F* the strongest position of the bar.

**Table XII.**

TRANSVERSE AND DROP TESTS OF ONE SIDE CHILLED BARS ALTERNATED TO BE IN COMPRESSION AND TENSION

| Test No. | Fracture and per cent of chill. | Width, inches. | Depth, inches. | Load, pounds. | Deflection, inches. | Modulus of rupture. | Drop | Set No. |
|---|---|---|---|---|---|---|---|---|
| 83 | Gray iron, slightly mottled.... | 2.39 | 2.06 | 21,070 | 0.045 | 42,760 | 7 | 20 |
| 84 | Chilled four sides; all white... | 2.12 | 2.18 | 23,380 | 0.040 | 41,770 | 15 | 20 |
| 85 | Chilled 5/8 inch one side; balance mottled; gray side in tension ..... | 2.06 | 2.05 | 21,590 | 0.030 | 43,435 | 9 | 20 |
| 86 | Chilled 7/8 inch one side; balance mottled; chilled side in tension ..... | 2.07 | 2.03 | 20,430 | 0.035 | 43,111 | 7 | 20 |
| 87 | Gray iron, slightly mottled.... | 2.11 | 2.07 | 19,420 | 0.045 | 38,664 | 8 | 21 |
| 88 | Chilled four sides; all white.. | 2.06 | 2.20 | 22,450 | 0.020 | 40,532 | 15 | 21 |
| 89 | Chilled 1/8 inch one side; balance mottled; gray side in tension ..... | 2.10 | 2.04 | 19,880 | 0.050 | 40,947 | 8 | 21 |
| 90 | Chilled 1/8 inch one side; balance mottled; chilled side in tension ..... | 2.06 | 2.06 | 13,660 | 0.030 | 28,132 | 6 | 21 |
| 91 | Chilled 1/4 inch one side; 3/4 inch mottled; gray side in tension ..... | 2.11 | 2.15 | 23,760 | 0.070 | 43,861 | 14 | 22 |
| 92 | Chilled 1/4 inch one side; 3/4 inch mottled; chilled side in tension ..... | 2.13 | 2.06 | 17,260 | 0.035 | 34,373 | . | 22 |
| 93 | Chilled 1/4 inch one side; 3/4 inch mottled; gray side in tension ..... | 2.12 | 2.10 | 21,760 | 0.055 | 41,914 | 7 | 22 |
| 94 | Chilled 1/4 inch one side; 3/4 inch mottled; chilled side in tension ..... | 2.13 | 2.06 | 13,190 | 0.025 | 26,378 | . | 22 |
| 95 | Chilled 1/2 inch one side; 1 inch mottled; gray side in tension ..... | 2.11 | 2.03 | 20,350 | 0.055 | 42,127 | 5 | 22 |
| 96 | Chilled 1/4 inch one side; 1 inch mottled; chilled side in tension ..... | 2.13 | 2.13 | 15,720 | 0.030 | 29,281 | . | 22 |

To obtain more favorable conditions for rapidly pouring the alloyed metal than was offered by the mold, Fig. 1, cupola chill blocks were used as shown in Fig. 3. The pair of chilled blocks, *R*, were poured with regular car wheel metal, cooled down to nearly the same temperature as that for pouring the chill block molds *V* and *T* having the vanadium and titanium alloys in their respective ladles. This method demonstrated that the vanadium increased the depth of chill, or held the carbon more in its combined form, while the titanium operated in the opposite direction. Numerous tests were made following this plan, some of which had a ½-inch chiller face plate in place of the 2½-inch plate *Q*, and all of them were effective in the same direction as to their respective results.

One test with the three sets of molds, Fig. 3, gave a difference in the thickness of chill as seen at *X*, *Y* and *Z*, Fig. 5. Set *R* was poured with the regular iron; set *V* with the vanadium and set *T* with the titanium alloyed metal, there being 1 pound of each alloy in about 175 pounds of metal.

Further experiments with 2 pounds of titanium in 175 pounds of metal gave a thickness of chill, shown at *V* and *W*, Fig. 5, of 1 and ½ inch respectively. Believing that by increasing the amount of titanium the chill might be wholly prevented, 4 pounds were put into the metal for two tests. This did not act as effectively as the 2-pound addition and showed that iron could not be prevented from chilling beyond a certain limit by its use.

### *Effects of Vanadium and Titanium on Contraction*

Tests to otain contraction were made with both round and square bars and are given in Table X. The 2¼-inch round bars show the contraction for a length of 12 inches and the square bars for 22 inches. The ratios for contraction of the bars cast on end agree closely with those of the bars cast flat. The regular irons are fairly uniform in their contraction. The vanadium bars show a greater contraction than those containing titanium, the latter having the least of any of the metals. The spurious metal of set No. 16, containing no ferro-manganese, shows the greatest contraction. The most radical difference exists between the all-chilled and all gray bars.

In making deductions of the relative strengths of the alloy mixtures, the round bars were selected chiefly on account of their uniform structure and greater uniformity of results. The gray round bar *A'*, Fig. 5, shows a much better uniformity of grain structure than exists in the square bars, *L* and *P*, Fig. 4. The latter contain irregular patches of grains embodying every structure from white at the corners *D'*, interlaced with mottled, leading to a gray center, sensitive to change with the least variation in the dampness or character of the sand, hardness in ramming and temperature of pouring metal. This irregularity of structure is apparent likewise in the all-white square bars *H* and *M*, Fig. 4, when compared with that shown at *B'*, Fig. 5.

The titanium bars showed an increase in strength over the regular bars, of 27 per cent in the white iron with bars 39 and 44, Table VI, and 32 per cent in the white iron with bars 59 and 64, Table VIII.

The vanadium showed an increase of strength of 9 per cent in the gray iron, with bars 48 and 53, and 17 per cent in the white with bars 49 and 54, Table VII.

The spurious bars which had no ferro-manganese or other alloys in them, showed a decrease in strength of 7 per cent in the gray iron, with bars 63 and 68, Table VIII. No comparison of the white iron in the round bars can be given, since there are no chilled round bars for this last set; but the contrast is so great in the square chilled bars 55 and 65, which show the white of the spurious metal, that it is safe to consider them 30 per cent weaker than the regular iron.

### *Comparison of Partly With Wholly-Chilled Bars*

In conducting this series of tests, bars were cast having only one side chilled as companion bars to the all-chilled and gray bars, as shown in the second test, Tables V to IX. It will be a surprise to many to find that in all the tests, except the two of set 14, the partly chilled bars are weaker than the all-chilled or white bars. A view of these three companion bars is shown in Fig. 4, *K* being the partly chilled side.

The weakness of the partly chilled bars is due to internal strains and scattered amalgamation of the state of the broken carbon of the metals. Bars showing nearly every effect of rapid and slow cooling, and not possessing the homogeneous blending of one char-

acter of grains, are illustrated by *H, L*, Fig. 4.

All the partly chilled bars showed the chilled body interlacing the mottled, the latter blending into the gray. This is generally considered to be a stronger section than one in which a distinct line marks the separation of the white and gray, and causes conditions such as can still further increase the weakness of partly chilled castings.

A feature of these tests worthy of consideration is the strength and deflection obtainable in strictly all-chilled or white iron. It is generally supposed that white iron is very much weaker than gray, and has very little if any deflection. By referring to tests Nos. 7, 21, 30, 35, 44, 49, 54, 69, 82, 84 and 88, it will be noted that white iron can be obtained at least 75 per cent as strong as gray. White iron is the strongest with the crystals radiating from a center as at *M* and *B'*, Figs. 4 and 5. The round bar excels the square in this form of structure.

The chief evil of white iron is its erratic strength and its easily spalling property. Numerous experiments were conducted to test the spalling weakness of white and gray iron and it was found that white bodies do not possess much over one-third the strength to resist spalling blows that exists in the gray or mottled of the same iron.

Table XI contains Brinell and scleroscope tests of three samples taken from each of the first three bars of sets 12 to 19. The Brinell depressions were produced by a ⅜-inch ball loaded with 6,000 pounds. Both the Brinell and scleroscope records are the averages of four to six tests on a sample. The columns *H, I, J. K* and *L* give the tests of the surfaces indicated by the same letters shown in Fig. 4. Those familiar with these tests know that there is some variation of hardness over the area although it may not exceed 1 square inch. The surface *H* had a variation of 3 to 7 points and *I*, 8 to 15 points; *J* about 6 points, while *L* had only 3 points, showing that a greater uniformity in hardness can be expected in all gray bodies than in mottled or chilled surfaces.

Table XI also shows that directly-chilled faces, as *H*, are harder than those crystallizing over a sand surface caused by the heat-absorbing effect of a chiller, some distance from such points, as *I*. The excessive variation of the surface *I* is believed to be caused by the curved structure of the heat radiation lines, as they come to the surface at an angle, differing from the straight lines shown on the sides at *H*.

The spurious iron is on an average harder than the regular iron. The alloys appear to have a hardening effect as compared with the regular iron, or that having only ferro-manganese in it. The irregularity in the effect of the alloy is no doubt due to the variations in the temperature of the metal filling the molds, and brings about variations in hardness similar to creating an irregularity in the chill, strength, deflection and contraction of like irons.

# Discussion of Mr. West's Papers

AT THE spring meeting of the American Society of Mechanical Engineers, held at Cleveland, May 28 to 31, two papers prepared by Thomas D. West were read and were discussed at length, "New Processes for Chilling and Hardening Cast Iron", the subject of one paper, was published in THE FOUNDRY, June, 1912, page 244. Mr. West's second paper, entitled "Tests of Chillable Irons," appears in this issue. That great interest was manifested in the chilling processes and tests outlined, is indicated by the numerous discussions, which are given in part herewith:

### *Carl Hering on "New Processes for Chilling Cast Iron."*

"Mr. West's interesting experiments and the commercial value of successful results, are good illustrations of the importance of studying more carefully the phenomenon of the flow of heat through bodies and to other bodies, a subject to which the attention, which its importance warrants, does not seem to have been given.

"Like an electric current, a flow of heat encounters a resistance which opposes or checks it more or less; hence, when the flow should be rapid, as in the chilling of a casting, this resistance to its flow should be kept as small as possible. The thermal resistance of the cast metal itself is a physical property of the material and is, therefore, beyond one's control, but the resistance between it and the chilling material can be controlled, and it is this resistance which is probably so much greater than all the others that it virtually governs the flow of the heat.

"The thermal resistance of the joint between two solid bodies, that is, at the surface of the mechanical contact, not soldered, seems to be, relatively, very high.

"When chilling a casting like a car wheel with an iron chiller, the heat must traverse the surface of contact and as the cast metal shrinks and the chiller expands, an actual separation must occur, and the very high thermal resistance introduced thereby will no doubt govern the flow of heat and reduce it greatly. This is shown by Mr. West's experiments in which he obtained a better flow of heat when he applied a pressure between the metal chiller and the shrinking casting. It is evident, however, that such a pressure contact cannot possibly be made between two cylindrical surfaces, as in casting car wheels.

"Another, and sometimes extremely high thermal resistance, exists between a metal and gas. A thin layer of very high resistance seems to be produced on the immediate surface. This is what limits the rate of the flow of heat from the flames to the water tubes of a steam boiler. A postage stamp pasted on the outside of a tin cup in which water is boiled over a flame will not char, showing an enormous drop of temperature through a layer of only a few thousandths of an inch in thickness, which is merely another way of stating that this layer has an extremely high thermal resistance.

"This high surface resistance can be destroyed by mechanically carrying away this film of gas and this is what Mr. West seems to have accomplished by chilling by means of a rapid flow of air in immediate contact with the metal. His results, therefore, seem to confirm this theory, or if the theory is acknowledged to be correct, his method of air chilling is a rational one, as it enables him to destroy this high contact resistance which would be difficult to do in practice between two metallic surfaces, and apparently quite impossible when the surfaces are cylindrical, as in the case of car wheels.

"Another advantage in cooling with rapidly flowing air is that it affords a possibility of controlling the flow of heat from the casting, hence also the depth of chill and its uniformity in successive castings. This would not be easy with metal chillers. Moreover, iron chillers are likely to be in actual, good, compressed contact at only a few points, and as the thermal resistance at those points would be considerably lower than at the rest of the surface, it is likely that the chill-

ing would be greater at those points and, therefore, not uniform."

*Discussion by P. Munnoch*

"It is very interesting to find that the phenomenon of internal chill, which has puzzled foundrymen for so many years, has been explained by Mr. West. Although the internally-chilled castings, occasionally occurring in practical foundry operations, have not been produced by quenching in water, nevertheless there is no doubt but that this is due to some rapid cooling effect at the period when the metal in the center is susceptible to rapid cooling. In reference to external chilling, the experiments of Mr. West have demonstrated that the chill structure is produced after the metal has solidified. This corroborates the work done by E. A. Custer with castings made in chill molds, which are without a chilled structure, provided the castings are removed from the molds immediately after the iron has set. The effect of a chill placed in a mold no doubt is greatest at the beginning of the chilling period, but as the temperature of the face of the chill block increases, the chilling effect is reduced considerably before the end of the chilling period. On the other hand, the effect of air chilling will continue equally efficient during the whole of the chilling period, which undoubtedly accounts for the good results obtained by Mr. West with air cooling."

*Discussion by Dr. Henry M. Howe*

"Mr. West found that, if after the outer part of a cast iron casting has solidified and cooled at a normal rate to somewhat below its eutectic freezing point and thus become graphitic, the casting is suddenly withdrawn from the mold and quenched in water at a moment when the interior has already solidified, the inside will be of white iron. The fact that the inside of the casting is white, although the normal slow rate of cooling extended to below the eutectic freezing point, shows that it solidified as white iron. Because the inside solidified as white iron, the outside evidently did also. The graphitization of the outside must have occurred in that phase of the cooling by which the gray outside had outrun the white interior at the moment when the quenching occurred.

"Because the amount by which the cooling of the outside outran that of the inside must have been slight, we infer that this graphitization occurred in a very narrow range of cooling, and presumably below the eutectic freezing point. The reason why the inside remained white may be either (1) that it hurried through the temperature just below the eutectic freezing point too fast to allow its cementite to graphitize; or (2) that the graphitization was restrained by the pressure put on the interior by the rapid cooling and contraction of the exterior; or, both these causes may have co-operated. In this particular case his further ingenious experiments showed, that if the slow cooling had not been interrupted thus, the interior would have been very gray.

"Thus Mr. West confirmed in a very simple and effective way the evidence of Heyn and Bauer that graphitization occurs chiefly immediately below the eutectic freezing point.

"The usual occurrence of white cores inside of gray iron pigs, so often reported, is probably due to pressure. If the outside of the casting becomes firm and rigid, the separation of graphite inside it immediately sets up pressure, because the graphite is so bulky, and the existence of this pressure tends to prevent the further formation of graphite in the parts further in. In most cases this tendency is resisted by the slower cooling of the interior than of the exterior, slow cooling in itself prolonging the opportunity for the graphitization of the cementite. Thus we have a struggle between slower cooling in the interior which tends to bring the carbon to the state of graphite, and pressure in the interior which tends to prevent it from assuming the form of graphite. In the majority of cases the slower cooling has the mastery and the interior of the casting is as graphitic as the outside, but in certain cases the effect of pressure has the mastery and restrains the formation of graphite in the interior of the casting. It may often happen that the throwing of a stream of water on the pigs after their outside has turned gray, but before the inside has, or their removal from the sand in cold weather at this point in their cooling, may, as in Mr. West's experiment, lead to an internal chill."

*Discussion by A. S. Dowler*

"Mr. West's paper presents something new and original for founders to think about and in my opinion it would be hard to predict, at this time, how far reaching the beneficial effects of the processes outlined will prove to wheel founders. Any method which will increase the depth of chill after the crust commences to draw away from the chiller should permit the use of softer and, sometimes, stronger grades of iron than is permissible in the manufacture of car wheels today."

*Discussion by James A. Beckett*

"The immersion test made by Mr. West seems to indicate that in this experiment he had more nearly reached the desired effect than in any of his tests. The results of this experiment opens up a new field for further investigation, and brings out what is a new idea which is sure to be the subject of still further experiment.

"A long experience in chilling cast iron has demonstrated that for surface chilling, no better chiller has been found, when cost and wearing qualities are considered, than the cast iron chiller, which is easily made and a fairly good absorber of heat. Surface chilling is almost entirely a matter of heat transference, but the efficiency of any chilling medium may be increased by the selection of a mixture of irons which have the tendency to a greater increase of combined carbon upon remelting, than is found in ordinary foundry irons.

"For many years, plow castings have been made by using the chiller for the cope of mold, in the upper surface of which was formed a receptacle into which warm or hot water was poured just before the iron was poured into the mold. The effect of the increased temperature of the chiller was to reduce the depth of chill in the casting, and by securing uniformity in the temperature of the chiller, produced a uniform density of grain in the fracture, without materially decreasing the strength of the casting. In this way castings were produced having a very close grain which was susceptible to a high polish.

*Surface Chilling*

"Surface chilling results from the instant withdrawal of heat from the surface of molten iron and is, to a limited degree only, proportionate to the thickness of the chiller used. This is true because the body of the chiller, regardless of its thickness, will not transfer the heat absorbed by the face of the chiller as rapidly as it is absorbed. The application of a jet of air to aid in the chilling process is a difficult operation, which will prove expensive and is not liable to come into use except in special cases.

"One of the conclusions of the tests follows: 'Graphitization having once taken place in the crust or body of a hot casting, no sudden cooling can restore the carbon to its original combined form, and only by remelt-

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

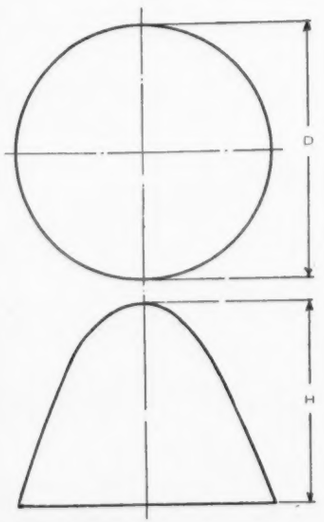
Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form

## FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS

*By W. L. Tryon*

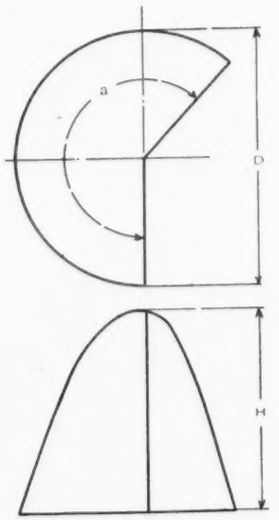
To find the weight of a paraboloid, multiply the diameter of the base squared by the height, by 0.102.

$$W = D^2 H \times 0.102.$$




To find the weight of a sector of a paraboloid, multiply the diameter of the base squared by the height by the number of degrees in the angle by 0.000281.

$$W = D^2 H a \times 0.000281.$$

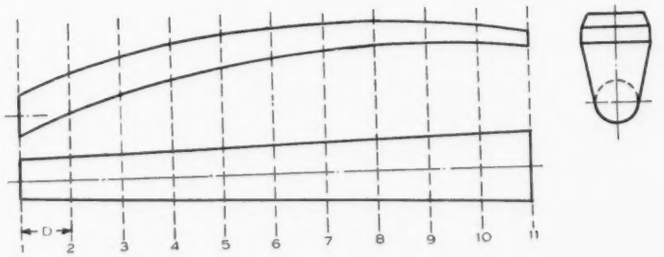



$W$ = Weight of casting in pounds.
$D$ = Diameter of base of paraboloid in inches.
$H$ = Height of paraboloid in inches.
$a$ = Number of degrees in the angle.

DATA SHEET No. 117, THE FOUNDRY, JULY, 1912.

## FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS

*By W. L. Tryon*




To find the weight of an irregular casting, which cannot be divided into elementary solids, use the following method based on Simpson's rule:

Divide the length of the casting into an even number of parts of equal length $D$ (the greater the number of divisions, the greater will be the accuracy in the final result) by parallel planes. Add the areas of the two ends and designate the sum $A$. Add the areas of the cross-sections made by the even cutting planes, *i. e.*, 2, 4, 6, etc., and designate this sum by $B$ and then add the areas made by the odd cutting planes except the ends, calling this sum $C$.

The weight of the casting is equal to the sum of $A$, 4 times $B$ and 2 times $C$, multiplied by $D$, multiplied by 0.0868.

$$W = (A + 4\,B + 2\,C)\,D \times 0.0868.$$

$W$ = Weight of casting in pounds.
$D$ = Length of division in inches.
$A$ = Area of both ends in square inches.
$B$ = Sum of areas of cross-sections made by 2, 4, 6, 8, 10.
$C$ = Sum of areas of cross-sections made by 3, 5, 7, 9.

DATA SHEET No. 118, THE FOUNDRY, JULY, 1912.

ing can it be so transformed as to have a chilled or white iron structure.' This law is not as positive in its action as Mr. West assumes, except in the case of gray iron. White iron used in the malleable iron industry, when annealed until practically all its carbon is in the graphitic form, may be restored to its original state, in which practically all its carbon is combined, by heating it to a cherry red and quenching it in cold water."

*By Alexander E. Outerbridge*

"Mr. West's discovery of the method of producing mechanically an inside chill in cast iron is, I believe, absolutely new, and apart from any application that it may have is very important, as it will solve a mystery that has long puzzled metallurgists. At one time I received several car loads of imported pig iron whose fractures showed an internal chill. The iron was quite high in manganese and I attributed the internal chill to that element. When used in our regular car wheel mixture no tendency to cause an internal chill was observed.

"The fact that a chilled face of a casting can be rendered harder by a cold air blast also is a valuable contribution to the metallurgical art. I can fully substantiate Mr. West's statement as to the effect of warming the chiller and my records show a reduction of chill in every case. In making comparative tests with powdered alloys in a ladle of molten iron. I always use a cast iron stirring rod, as I have found that the strength of the iron is always appreciably increased when a wrought iron stirring rod is used. When making test bars two sets of test molds are employed and, in addition, thin fluidity strips, 10 inches long by ¼ inch thick, tapering to a feather edge, are cast. The metal from the bull ladle is poured into two clean hand ladles; both tested and untreated samples are stirred with cast iron rods and both are poured at the same time so that all conditions will be similar. We also pour shrinkage test pieces for the purpose of developing any tendency to produce blow-holes at the junction of light and heavy sections. These methods have been in practice since the time when I began to make extensive experiments on the effect of adding small quantities of powdered ferro-manganese to car wheel iron in ladles about 25 years ago."

*Mr. Beckett Discusses "Tests of Chillable Irons"*

"While this paper, in the main, is a continuation of the research by which Mr. West has contributed much valuable labor while working out and demonstrating the value of his theories as to uniform test bars, it furnishes another instance where the standard test bar is not as reliable for special work, as it is for ordinary foundry use. He demonstrates the fact that a larger test bar will give more accurate results in white, or chilled gray iron.

"In the discussion, a few years ago, of the subject of a uniform standard test bar by means of which all the different varieties of cast iron might be subjected to a uniform test, the question was often asked if it were possible to make a test bar small enough so that it would not be too sensitive for accurate results in white or chilled iron testing.

"The writer has always held that while breaking tests of cast iron are at best of uncertain value, and the comparison of particular bars in any test, should not be given too much weight to obtain a fairly accurate knowledge of the strength of a casting the test bar used should nearly represent in its fracture, the average fracture of the castings which it represented. Because, unless the character of the fracture of the casting is known, the value of the test can not be determined with any degee of accuracy.

"The increase in the deflection of all-chilled or white iron which is referred to, is more apparent than real, and is probably influenced by the size of the test bar used. The difference in deflection between soft gray iron and chilled or white iron, is much more apparent when a smaller test bar, more sensitive to variations in cooling, is used. Some of the old time stove makers used a deflection test to determine the softness of their mixture of iron in which the test bar used was made from a pattern, 24 inches long, 2¼ inches wide and ⅛ inch thick, tested on supports 20 inches apart, the load applied in the center. This test was used long before foundrymen had the assistance of chemical analysis in determining the cause of their troubles, and it is surprising how sensitive were the results otained by this crude test, in the soft irons used in stove making.

"While great strides have been made in the subject of testing cast iron during the past 20 years—in the advancement of which Mr. West has given much valuable labor—the subject is still in its infancy and much labor must be given to research along the lines of this paper, before we can safely assume that our practice is correct."

Paul Kreutzpointner, in a written discussion, stated that all chillable irons are chiefly used where they are subjected to crushing and bending stresses and the best manner of testing them, therefore, is by the application of crushing, bending and drop or pendulum tests.

*Charcoal Iron in Car Wheels*

In the discussion of Mr. West's paper from the floor, J. E. Johnson Jr., of the Lake Superior Iron & Chemical Co., referred to the importance of the iron chilling problem. He was of the opinion that the best chilled car wheels can be made only by the use of charcoal pig iron. Chemical analysis, he claimed, is not always an index of the quality of pig iron, and even the microscope he did not consider an infallible means of revealing why one grade of iron is better than another.

B. D. Fuller, of the Westinghouse Electric & Mfg. Co., said that damp ladles are the source of much trouble in foundry operation, and the dampness of the molds is frequently the cause of segregation spots in castings. So many conditions affect the quality of iron, he stated, that it is not unusual to obtain castings of varying physical properties, from day to day, poured from mixtures of the same analysis.

## Making Manganese Steel Castings Machineable

A method of softening manganese steel castings by heat treatment so that they can be machined with the same facility as ordinary steel castings, has been patented by F. Kohlhaas, Dusseldorf, Germany. The castings are heated to a temperature which increases in accordance with the percentage of manganese they may contain, and varies between 1,700 and 2,260 degrees Fahr. The duration of the treatment depends upon the size of the castings, and an important part of the process is the exclusion of air, both during the time of heating and the subsequent cooling. This is accomplished by sealing the castings in refractory receptacles, in which they are afterward allowed to cool. It is claimed that after this treatment, the steel is so changed in structure that it can be machined easily, and after the work has been done on it, the steel may be easily restored to its former condition of strength and toughness by heating to a bright yellow heat, and suddenly cooling in water.

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The Pittsburgh Testing Laboratory, Pittsburgh, has established an office at 204 White building, Seattle, Wash., in charge of C. A. Perkins.

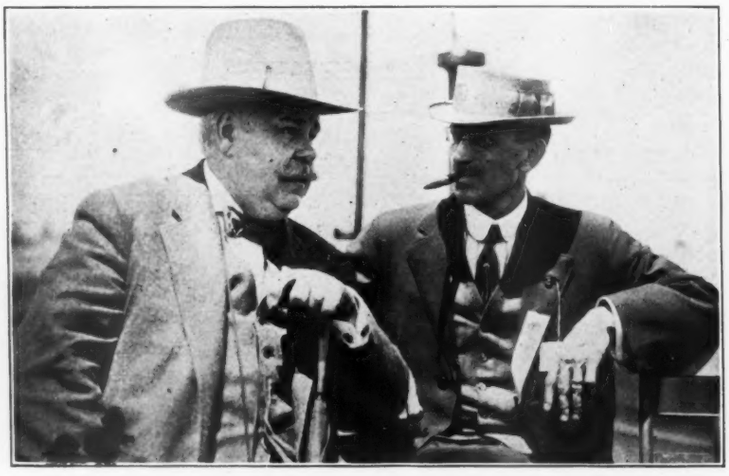
# Outing and Annual Banquet of the C

JAMES WOOD,
President Chicago Foundrymen's Club

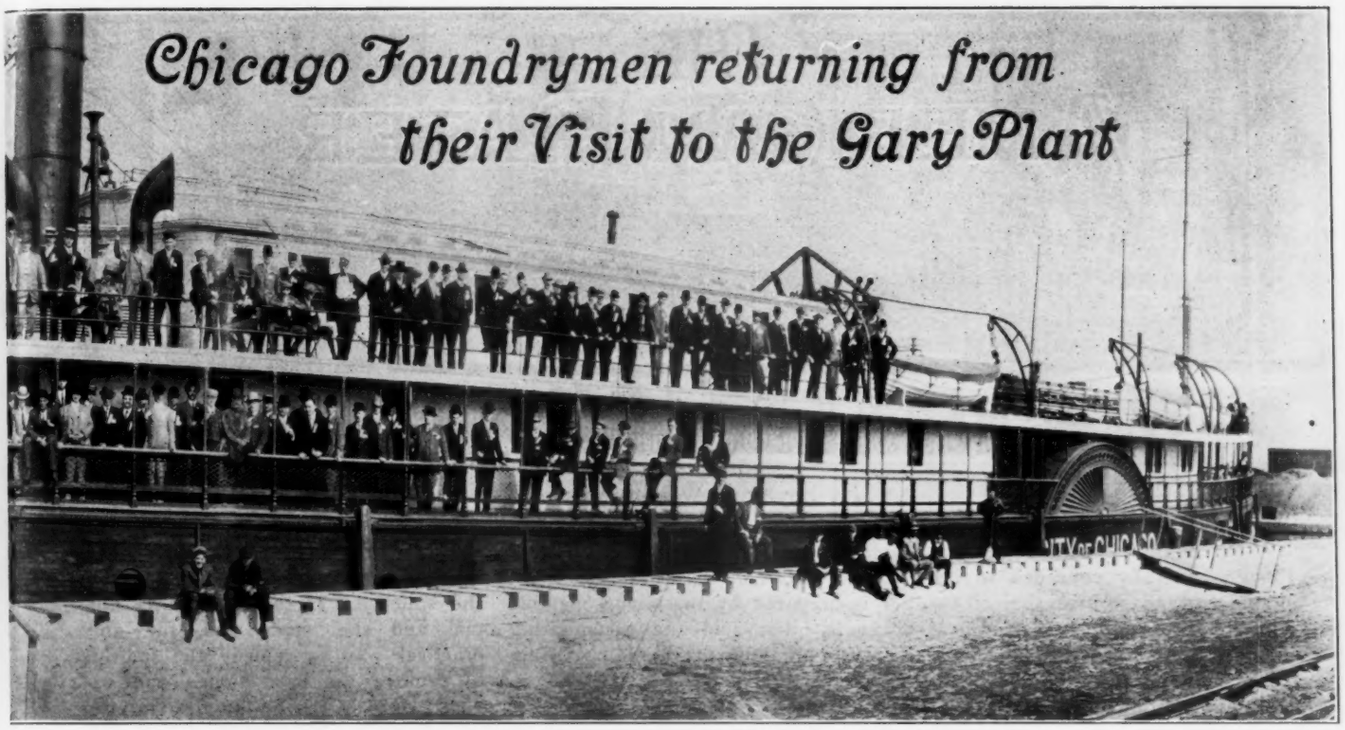
SATURDAY, May 25, was Foundry Day in Chicago. Under the auspices of the Chicago Foundrymen's Club an excursion by boat was made to the Gary steel plant of the United States Steel Corporation, followed in the evening by a banquet at the Auditorium hotel. About 300 enthusiastic foundrymen from Chicago and vicinity attended. The party left the city at 11:00 a. m. on the steamer City of Chicago and docked at the steel works at 1:30 p. m., where a special train was waiting to carry them through the mills. Perfect weather added to the enjoyment of the day. A luncheon was served on the boat en route to Gary. All parts of the steel plant were visited, including the ore yards, dock, coke ovens, blast furnaces, open-hearth department, etc. The train also made a circuit of the shipping and classification yards at the west end of the mill property, affording the visitors a glimpse of the city of Gary and of the new mills of the American Sheet & Tin Plate Co. The steamer left Gary for Chicago at 4:00 p. m. and cruised on the lake until 7:00 o'clock.

A buffet luncheon was served en route returning and the Lewis Institute Glee Club furnished a musical entertainment.

Following the trip to Gary, the annual reunion banquet of the Chicago Foundrymen's Club was held at the Auditorium hotel, about 200 being present. Places were reserved at the speakers' table for a number of distinguished guests who had been with the party on the trip during the day. These included Major Joseph T. Speer, president of the American Foundrymen's Association; R. A. Bull, of St. Louis, and W. D. Miles, of Buffalo, vice presidents of the A. F. A.; Dr. Richard Moldenke, secretary; Frank W. Tracy, of Buffalo; Arthur T. Waterfall, of Detroit, Thomas D. West, of Cleveland, and W. M. Corse, secretary of the American Institute of Metals. The pro-



MAJOR JOSEPH T. SPEER, PRESIDENT OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, AND R. A. BULL, HOLDING A CONFERFERENCE ABOUT THE BUFFALO CONVENTION




# Chicago Foundrymen's Club

gram following the banquet was opened by James Wood, president of the Chicago Foundrymen's Club, who spoke briefly on the purposes of the local foundrymen in forming their organization and also on the achievements and aims of the club. Mr. Wood then introduced H. O. Lange, of the Foundry Co., who officiated as toastmaster. W. A. Jones, of Chicago, ex-president of the American Foundrymen's Association, in a few brief remarks compared foundries in foreign countries with those in the United States and expressed the opinion, based on extended travel, that nowhere in the world are foundries better equipped or more skillfully managed than in the United States. He stated that the most primitive foundries were to be found in India, where many of the plants use bellows for furnishing the blast necessary to melt the iron. Mr. Jones had no compliments for the Japanese foundries, stating that as far as the art of casting is concerned, the Japanese are merely imitators and have shown little ability for original work.

Thomas D. West, of Cleveland, called attention to the dangers of modern specialization. He said, "We are losing the art of founding because our workmen are overspecialized and are not mchanics thoroughly grounded in the general principles of their trade." He urged the necessity of taking steps to train workmen with a broad knowledge of foundry practice.

W. D. Miles, chairman of the local committee in charge of the foundry convention which will be held in Buffalo, Sept. 23, extended a cordial welcome to all Chicago foundrymen to attend this event and promised to have the best foundry convention ever held in America. Mr. Miles' remarks were supplemented by Frank W. Tracy, of the Buffalo Chamber of Commerce. Brief remarks were also made by Major Speer, Dr. Moldenke, R. A. Bull, Arthur T. Waterfall and Wm. Corse. The evening concluded with an address by the Rev. John Timothy Stone, of the Fourth Presbyterian church of Chicago. As a result of the success of this outing, Foundry Day will be celebrated annually by the foundrymen of Chicago and vicinity.

ON THE CITY OF CHICAGO, EN ROUTE TO GARY
Front row, seated, from left to right—W. M. Corse, secretary A. I. M.; H. O. Lange, vice president, C. F. C.; Dr. Richard Moldenke, secretary, A. F. A.; Major Joseph T. Speer, president, A. F. A., and R. A. Bull, vice president, A. F. A.

# Solutions for Silver Plating

By Seymour W. Rowsbar

SILVER plating solutions, although generally conceded to be simple to manage, are subject to variable conditions which sometimes prove difficult to correct; this is especially true of old solutions. If, however, the solution is given considerable attention when replenishing with cyanide and silver, and is filtered with due regard to cleanliness, it can be used for an indefinite period. The more progressive platers are gradually awakening to the fact that a silver solution should not be operated too concentrated if best results are expected. Such a solution at its best, produces no better deposits than a solution of normal strength, the results often being inferior. The maintenance of a solution containing an unnecessary amount of silver is bad practice from an economical standpoint, 3 or 4 ounces of silver being quite sufficient. If a highly concentrated solution is required, experiment in this direction during the summer months, and as cold weather approaches the condition of the bath should be carefully noted and proper allowances made for lower temperature if uniform results are to be obtained.

*Most Practical Solution*

The most practical solution for general purposes is the double cyanide, the preparation of which requires care to avoid an excess of cyanide. One part of silver to two parts of potassium cyanide are about the proper proportions. In time the solution may become alkaline from use and will contain an excess of potassium carbonate by the decomposition of potassium cyanide. This may be corrected by adding about ¼ ounce of hydrocyanic acid (prussic acid) to every gallon of solution. The potassium carbonate is converted into potassium cyanide and the solution is properly filtered. The cyanide of silver is prepared by dissolving metallic silver in nitric acid and precipitating it with potassium cyanide, washing thoroughly and re-dissolving it in excess of the potassium salt. The water and all the chemicals used in preparing the solution must be pure as the presence of foreign matter is injurious to the deposit. Any form of organic matter is especially harmful and constant care is required to avoid contamination as cyanide acts as a solvent for many organic bodies; 12.4 parts of pure silver cyanide are obtained from 10 parts of pure silver, or, if preferred, the silver cyanide may be prepared by dissolving pure, crystallized nitrate of silver in water and adding potassium cyanide in solution until no further precipitate forms, care being exercised to avoid an excess of cyanide which would re-dissolve a portion of the silver precipitated. Then filter out the precipitate, wash thoroughly and re-dissolve with potassium cyanide. This method, while a trifle more expensive and less rapid, is preferable to the chloride of silver method and the deposit obtained is better, heavier and requires less time to produce.

With a good solution the next important requisite is pure anodes. Do not tolerate an anode which has to be hung in a bag to prevent the dirt or film from it escaping and attaching itself to the work. In this day such a procedure is uncalled for. Anodes which work clean are obtainable and the cost is less in the long run. Silver anodes will become black even though the silver from which they are manufactured is pure. An excess of inferior cyanide or too dense a current is among the common causes. The black film prevents the free cyanide in the solution from dissolving the anode and, in consequence, the deposit is obtained from the solution. If the solution is normal and the anode bad, the only practical way to remedy the fault is to remove the bad anodes and use good ones. Reputable dealers can now furnish silver anodes which will work uniformly clean and white from the first immersion to the last. An anode of this standard reduces the amount of silver salts required to maintain a solution in good condition. If rolled silver anodes are used they should be annealed by heating to a dull red heat and allowed to cool, thus rendering them softer and more readily soluble under the action of the electric current.

*Preparing the Work for Plating*

The bath being prepared and ready for use, proper cleaning of the work is required. Here is where many platers fail, sufficient care not being given the cleaning bath. The solution should consist of some alkali or caustic which has the least tendency to attack the surface of the metal being cleaned and yet it should be of sufficient strength to loosen or remove the grease or dirt from the surface. The solution should not be used too long before cleaning. A dirty potash solution is a constant source of trouble to the silver plater. Siphon off the upper portion of the solution and throw away the remainder. This should be done in the morning after the solution has remained undisturbed all night. This method avoids the preparation of an entire new solution which requires a certain amount of use before cutting the grease readily. After removal from the cleaning solution the articles must be scoured carefully to remove any film which may have formed while in the cleaning solution. Failure in the re-

moval of such films is the cause of subsequent, non-adherent deposits, the cause often being blamed to the silver plating solution.

The current density for all ordinary work may safely be 0.032 ampere per square inch. This current produces a strong, malleable, adherent deposit very rapidly. It is often contended that one ounce of silver per square foot of surface in one hour is the limit accomplished by one ampere. Many platers today are producing twice this amount. When using bisulphide of carbon for brightening silver solutions, bear in mind that merely a trace is required to brighten the deposit, a surplus will render the deposit gray. The bisulphide must be completely taken up by the solution in which it is prepared before adding to the bath; therefore, allow plenty of time to elapse after preparing the brightener before actually placing any in the plating tank. Large quantities of goods are now being silvered on a deposit of nickel and as an additional economy an extra durable, transparent, silver lacquer is used. It is needless to say the silver deposit is a very light one, such methods being only permissible on ornamental work or the cheaper grades of novelties.

# TROUBLES OF THE ELECTRO-PLATER

## *Discussed by Practical Men*

### Nickel Stripping Solution

*Please advise us of a simple method of removing nickel plate from brass pieces which have received a defective deposit and must be refinished.*

We presume you desire a chemical or electro-chemical process. One of the largest camera manufacturers in the country uses a solution of 1 pint of muriatic acid to 1 gallon of water with the electric current. The articles to be stripped are used as the anode and a piece of nickeled brass as the cathode. The muriatic acid does not attack the brass as nitric acid or sulphuric acid would under similar conditions. A current of from 3 to 6 volts is employed.

### Trouble With a Nickel-Plating Solution

*We nickel-plate large quantities of small parts on trays and the solution which we use regularly for this purpose has gone wrong. The work takes on a dirty color, almost black, and there is practically no deposit. We use 3 volts and the solution stands at 7 degrees. The tank is well lined with anodes of good quality. What should we do?*

We are of the opinion that the solution is deficient in metallic salts and is also alkaline. The strong current you employ naturally causes the alkaline condition and may be corrected by the addition of 5 ounces of sulphuric acid to each 100 gallons of solution. This amount possibly may not be sufficient to render the solution neutral, but the further addition of 2 or 3 ounces of single nickel salts will help; also add metal to the solution. If the solution is then only neutral, we advise the addition of 2 or 3 ounces of sal-ammoniac to each gallon; work the bath a day or two before adding more acid. The acid may be used each week in order to maintain the solution in proper condition and to produce a white deposit.

### Silver Solution

*Will you kindly furnish me with a formula for a good silver solution for general purposes in a jobbing shop?*

Make a solution of nitric acid, 15 ounces, and water, 15 ounces. In this solution dissolve 3 ounces of metallic silver; as silver does not dissolve readily in undiluted acid, the water is required. If the vessel containing the solution is warmed, the operation will be hastened. When the silver has been dissolved, add one gallon of water and thoroughly stir the solution, adding hydrochloric acid gradually while stirring until the precipitation of chloride of silver ceases. Common salt may be used instead of acid if preferred. When the chloride has all been precipitated, stir the solution well with a rapid motion, which will cause the silver to collect and settle rapidly. Allow it to settle and pour off the clear liquid. Add water and wash again. Repeat the washing process until blue litmus paper is not turned red by the liquid. The point to bear in mind is to completely eliminate every trace of acid from the chloride before proceeding. When the chloride is properly washed, dissolve it in one gallon of water in which has previously been dissolved 12 ounces of cyanide of potassium. Avoid letting the chloride become dry, as in this state it is difficult to dissolve. When thoroughly dissolved and mixed in the cyanide solution, the process of making the silver solution is finished and it is ready for use.

### Spotted Nickel-Plated Surface

*When polishing nickel-plated stove castings, small black spots develop. We would like to know whether these are due to the iron or whether the plating process is at fault.*

The small black spots on nickel-plated stove castings may be due to several causes. As the method employed in handling these castings is not outlined, we are unable to reply as satisfactorily as we should like to. If the castings are nickeled direct on the iron the spots may be caused by hard spots in the castings which the polishing wheel failed to remove. As these spots consist of a skin of oxide they do not permit of the formation of an adherent deposit and the removal of the nickel-plated deposit discloses the oxide. Blow-holes directly underneath the surface which are indicated by pin-holes will hold the pickling solution or potash and will produce a black spot after plating. Small pin-holes from slag or oxide will frequently remain unnoticed until the piece is finished and then appear as black spots as the nickel deposit magnifies this defect. A porous casting is liable to produce these spots unless properly pickled, or sand-blasted and thoroughly cleaned and rinsed when being prepared for plating. If the castings are coppered in a hot cyanide bath before nickeling, the cyanide may cause a stain to form arcund the pin-holes after plating unless removed by rapid rinsing in hot and cold water used alternately so as to contract and expand the metal and thereby expel the solution. The castings on the other hand may be immersed in a dilute solution of sulphuric acid and water and dried by a whale oil soap solution. The nickel

solution should not produce these spots unless very alkaline.

## Rose Gold Finish

*Can you furnish us a solution for froducing a rose gold finish?*

Dissolve 2 ounces of potassium ferrocyanide in one gallon of water, adding 2 ounces of carbonate of soda crystals (sal-soda); stir well and when these chemicals have been completely dissolved, add ¼ ounce of chloride of gold. This will cause the formation of a precipitate of iron hydroxide which must be filtered out before using. A good method of doing this is to boil the solution for about 15 minutes in order to coagulate the iron hydroxide. It may then be filtered through filter paper. After filtering a clear yellow solution remains. This is the gold solution and should be used at a temperature of about 180 degrees Fahr. in order to produce a rose tint. As the solution is a poor conductor of electricity, a high voltage is absolutely necessary and from 5 to 6 volts are used so that gas is evolved freely. The best results are obtained on acid copper deposits; less gold is required and the matte surface of the acid copper base is especially suited for this finish. High lights, of course, are finished off on a wheel.

## Cleaning Nickel Solutions

*How frequently should we remove the mud which collects in the bottom of our nickel plating tank? We have been plating with our solutions about four months and they seem quite dirty. The solution which was at first clear is now cloudy in appearance.*

Much depends on the use and abuse the solutions have received. Large firms employing thousands of gallons of nickel solution operate them for 12 months without cleaning. If the tank is deep enough to allow the collection of slime to rest sufficiently low so that work does not disturb it, it can do no harm, otherwise clean the slime out as soon as indications show it interferes with the work. Cleanliness in preparing the work and care in operating the solution will have a tendency to reduce the frequency of cleaning. Your solution may appear turbid and yet be free from a troublesome amount of slime. Such a condition is caused by the use of large quantities of common salt as a remedy for iron conductivity, or it may be alkaline. A sheet of newspaper floated over the solution will remove a film of oil or particles of dust from the surface. The tank should be 6 or 8 inches deeper than the length of the longest pieces plated in it. The cleaning of nickel anodes is a subject upon which platers differ greatly. Some clean them once a week, while others never remove them until exhausted. Either of these methods may be classed as extremes. Keep the plating room as free from flying sawdust or other dirt as possible. Practice cleanliness in the preparation of the work and its disposal in the solution. Avoid scraping the anodes when hanging in or removing work and ordinarily you will not have to filter the solution oftener than once a year.

## Preparing Steel For Plating

*We have installed a polishing lathe, nickel tank and dynamo in our repair shop and contemplate doing our own plating. However, we do not get the same finish on the articles which other platers obtain, the work showing all the marks left in the steel. What is the cause of this poor finish?*

We are inclined to believe that you have attempted to polish and plate the work without first cutting it down or removing the old plate scratches, etc. New work should be cut down with a wheel, set up with emery sufficiently coarse to remove the outer surface, then run over a wheel of finer emery to remove the emery marks of the first wheel. The article then should be oiled or in some cases it may be ready to plate. Such a finish should suffice for your purpose. Nickel deposits are transparent and really magnify defects in the base beneath it. These must be removed mechanically in order to obtain a proper finish. The services of an experienced polisher for a short time would help you in getting an idea of what is required.

## How To Operate a Brass Solution

*We have been trying to run our brass solution hot, but obtain anything but a good yellow color. The temperature of the bath while in use is about 180 degrees Fahr., but the work is a dirty brown color. Is it essential that a brass solution be made up special in order to be operated hot?*

A brass solution worked at 120 degrees Fahr., is sufficiently hot. This may appeal to you as being only warm, but if the bath is operated at a higher temperature, it produces no better deposit, and if ammonia is used, it evaporates so rapidly that it is wasted and the bath works irregularly. The point to bear in mind is that a warm brass solution will require a greater amount of zinc to produce a yellow color. A warm bath has the advantage of depositing metal faster than a cold bath and the color should be better. If the deposit is dirty or of an indifferent color and you use brass anodes, dissolve ½ pound of cyanide of potassium in one quart of ammonia and add ½ pound of carbonate of zinc. Add small quantities of this mixture to the brass bath and if the copper content is all right, the color will come up a fine yellow. If not satisfactory, the bath is deficient in copper and more carbonate of copper should be added. Be sure that you are using sufficient current before altering the bath. A cold brass bath is inclined to produce a pale yellow color devoid of the depth and snap characteristic of a deposit from a warm bath. If you are using copper anodes you will require nothing but cyanide and zinc to maintain a uniform color and this will require but little attention.

## Plating To Enlarge Iron and Steel Objects

*Our firm has a large number of jack shafts and knuckle joints, such as are used on motor cars. These pieces have been machined too small, in many cases from 0.005 to 0.007 inch, and are unfit for use. Can you suggest a method which would be sufficiently practical to use for the purpose of enlarging them? If scrapped it means considerable loss.*

The shafts and knuckle joints may be increased in size and used as originally intended by depositing a heavy coat of copper on them in an acid copper solution. Copper plate them first in a cyanide copper bath, then deposit slightly more copper than necessary to make a good fit by using the acid bath. They may then be turned down to exact size. Bearings where roller or ball containers are used will allow of this treatment, but a piece used where there is a possibility of wear will not give satisfaction, owing to the soft nature of the copper. Various firms resort to this method of saving parts which otherwise would be useless.

## An Alloy of Aluminum and Silver

An aluminum alloy recently patented in France is composed of aluminum and silver, with the addition of any one of the iron group of metals, such as cobalt, chromium, manganese or nickel, according to the intended use of the alloy. The proportions recommended follow: Aluminum, 80 to 90 per cent; silver, 5 to 10 per cent; chromium, cobalt, nickel or manganese, from 5 to 15 per cent. The alloy is intended for the manufacture of aeroplane or automobile motors, and is claimed to be very tough and hard. The hardness of the mixture cannot be questioned, as all the metals mentioned in the specifications harden aluminum, imparting also extreme brittleness, which seems incompatible with the claims of toughness made for the alloy.

# Molding a 26-ton, Gray Iron Turbine Casting

*How economies were effected by the use of a skeleton pattern and details of molding and casting*

WHEN the Builders Iron Foundry, Providence, R. I., received the contract to cast the casings for the turbine cylinders for the battleship Utah, building at the plant of the New York Shipbuilding Co., Camden, N. J., one of the problems presented was the casting of each half of the low pressure cylinder in one piece. The specifications provided that the casting be made in two halves, bolted together at the joint. The object of this plan was to permit of machining the pieces more readily. The casting of the cylinders in accordance with these specifications involved more than ordinary difficulties owing to the size and irregular form of the castings, and considerable ingenuity was displayed in molding the turbine casings. The manner in which the problem was solved by the Builders Iron Foundry affords an interesting series of operations in loam molding. The bore of the low pressure cylinder casting was 10 feet, 6 inches in diameter and 19 feet long. Each half of the casing weighed about 26 tons. The castings were required to develop a tensile strength of 26,000 to 30,000 pounds per square inch and a special gray iron mixture was employed to meet this physical test.

### *The Molding Pit*

The molds were made in a pit, 26 feet long, 19 feet wide and 8 feet deep. The pit was lined with cast iron curbing about 1 inch thick. The bottom plate upon which the mold was built was 4 inches thick and weighed about 22 tons. This plate was cast in open sand, the mold having been struck-up on the foundry floor. The plate was lowered into the pit by two traveling cranes. Owing to the great weight of the various parts of the mold, some of which aggregated 30 tons, and to the large quantity of metal that had to be poured, it was necessary that the pit be so located that it could be freely commanded by the two cranes serving the foundry. For this reason the pit was located in the center of the shop where both the cranes command the operations. After the plate had been lowered into position on the bottom of the pit, a bed of loam was swept-up upon it for the pattern to rest upon.

A very important step in the casting of the cylinder casings was the planning and execution of the pattern work. It was of essential importance that the castings be cast accurately to thickness, which was approximately 2 inches. After due consideration, it

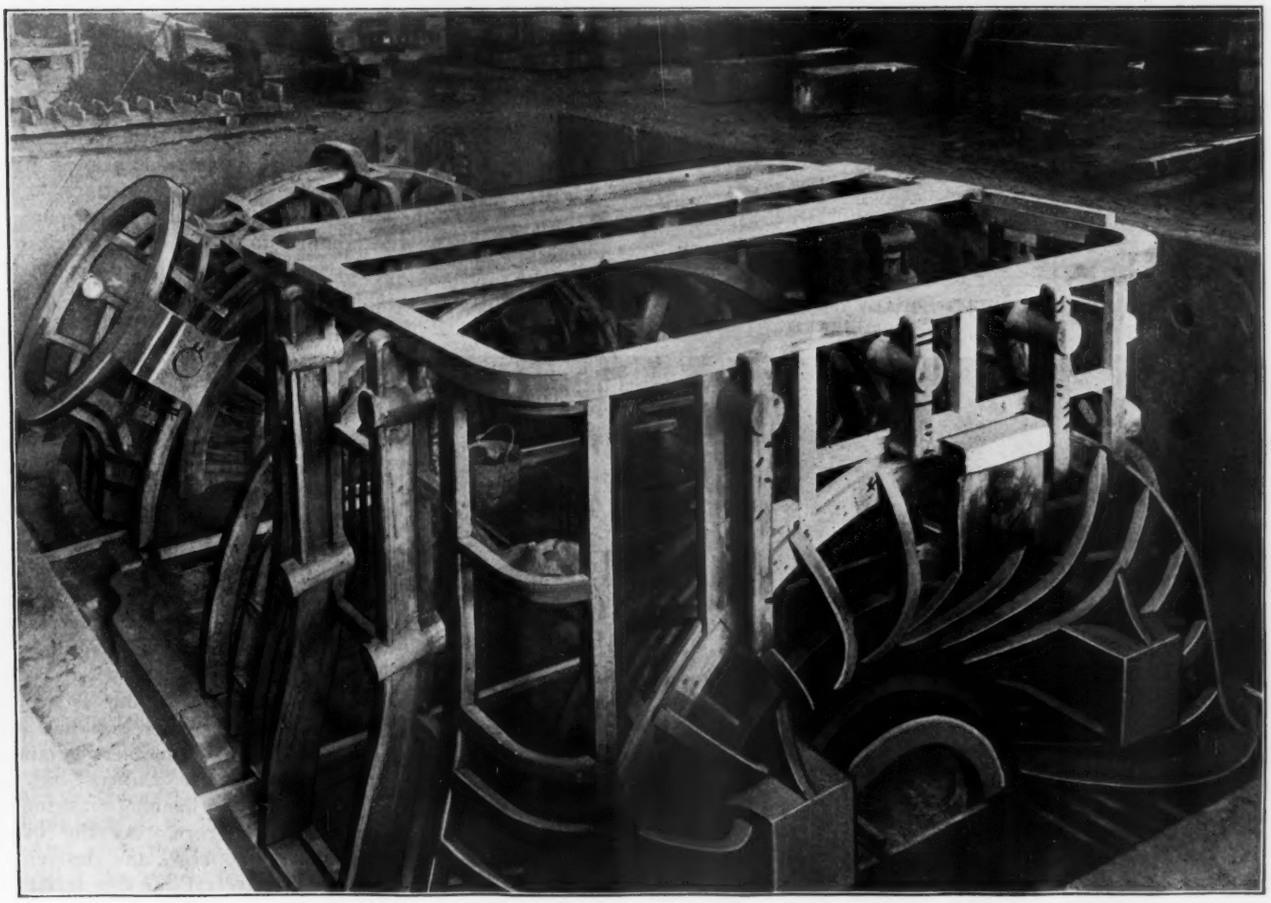


FIG. 1—SKELETON PATTERN IN THE PIT IN POSITION ON THE BOTTOM PLATE READY FOR TO BE MOLDED

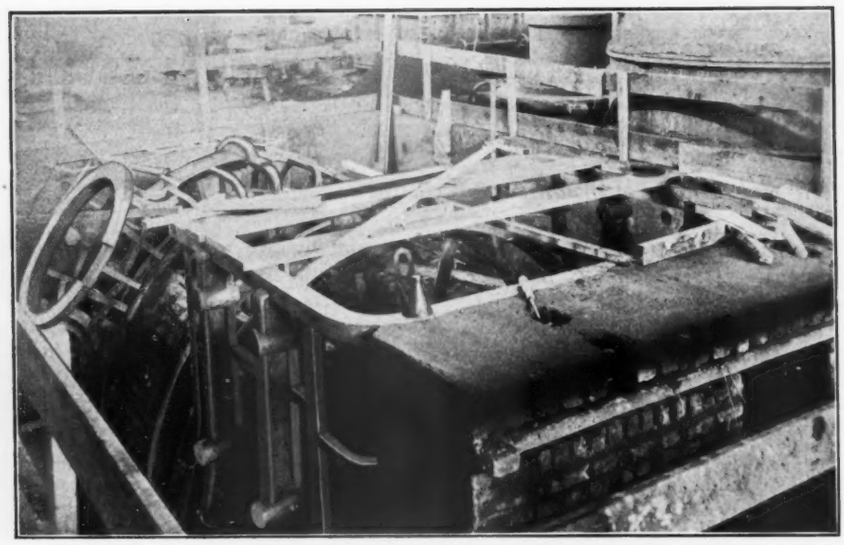


FIG. 2—THE BRICKWORK FOR THE CORE OR DRAG HALF OF THE MOLD IS SHOWN UNDER WAY, AS WELL AS ONE OF THE DRAWBACKS

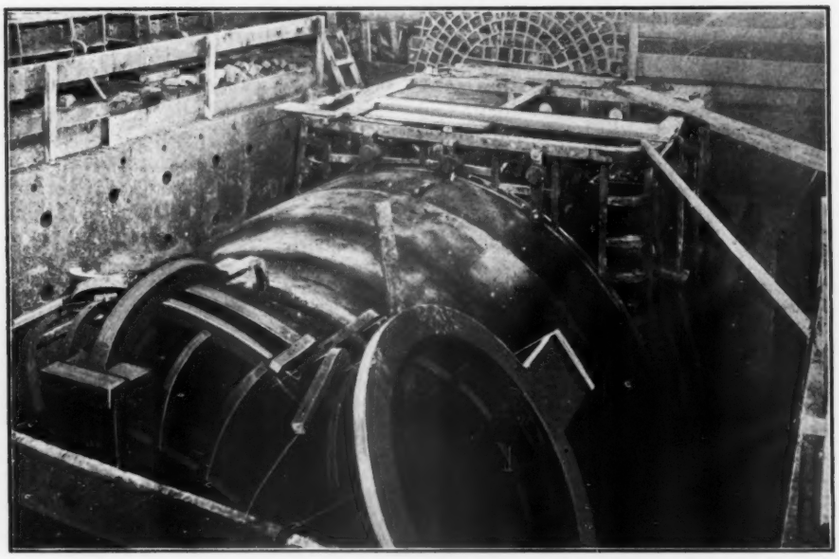


FIG. 3—THE CORE FURTHER ADVANCED WITH THE LOAM THICKNESS APPLIED

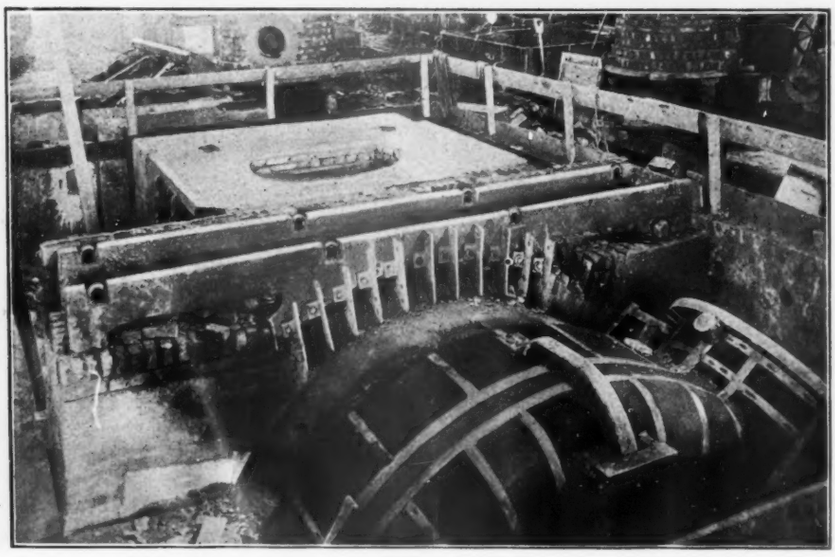


FIG. 4—THE MOLDING OF THE CORE OR DRAG COMPLETED AND THE CHEEK IS WELL UNDER WAY

was decided that a skeleton pattern would best meet the requirements, and this type of pattern construction was adopted. To have used a solid pattern would have multiplied the expense both in lumber and labor, and the pattern would have been so heavy that it could not have been handled readily. Furthermore, it was concluded that accurate results could not have been obtained because of the irregular outline of the cylinder surface with its nozzles, flanges, etc. The pattern was very carefully made and required about four weeks to complete. It was assembled entirely with screws, no nails or glue being used. This feature enabled the molders to loosen the pattern sections as they completed the various parts of the mold. All the ribs, flanges and loose pieces of the pattern were finished on a disc grinder instead of by hand. By this method, considerable time was saved and the cost of finishing was reduced to a very low figure.

*Making the Mold*

Fig. 1 is a general view of the skeleton pattern in the pit resting upon the bottom plate and ready for the molding operation. After the pattern had been placed on the bottom plate in the pit, and had been weighted in place, the molders proceded to build up the core and mold. Two or three courses of brick were laid upon the bottom plate to conform to the inside shape of the pattern. The brickwork was built far enough away from the inside form of the pattern to allow for a good thickness of loam to be applied to the former, which was strickled off accurately to the inside level of the framework. The center of the core was filled with cinders and small pieces of brick to aid in venting.

*The Cores*

The pattern was constructed so as to enable the molders to ram all of the nozzle cores onto the main core. No dry sand cores were employed. By this method the desired thicknesses of the mold were obtained very accurately and no unsightly fins were produced on the casting which would have entailed considerable expense for chipping. Instead of having this extra chipping to do, as would probably have been the case had dry cores been used, the molders obtained symmetrically-rounded corners on the casting where the opening cut through onto the main core. As the main core was very large and heavy, it was made in several parts to facilitate lifting it out of the pit by crane. These sections were dried in ovens

before being finally set in the mold. In Fig. 2 the core is shown in course of construction. The brickwork on the interior of the pattern is clearly illustrated, especially that part conforming to the segment of the cylindrical portion of the pattern. One part of the completed core, with the loam thickness applied, is shown in Fig. 3. Fig. 4 shows the next stage of mold construction, the core having been completed entirely with some of the rigging in place. Several of the bars forming the cope are also in place. One side of the cheek is in place in Fig. 5, and the complete core is shown in Figs. 7, 8, and 9. In Fig. 7 the main core is ready for the oven. The core, after its removal from the oven and after it was again assembled in the mold, ready for the cope, is shown in Fig. 8. In Fig. 9 the complete core is in position and part of the cope is in place.

*Obtaining the Metal Thickness*

After the core had been built-up to the inside form of the pattern, the molders applied a layer of molding sand equal to the thickness of the metal in the casting. This was carefully strickled off to conform to the outside contour of the pattern. The effect of a complete pattern was thereby obtained. After the cope was molded and lifted away this layer of sand was removed, leaving an opening equal to the thickness of the casting between the core and the cope. Upon this layer of sand the brickwork of the cope and cheek, together with the loam thickness, was built.

In preparing the cope portion of the mold, the irregular form of the casting made it necessary to employ a number of drawbacks. This plan of mold construction facilitated the removal of the pattern after the mold had been completed. A number of joints also had to be carefully finished after the mold was assembled. Care was exercised to locate these joints at points in the mold where the pattern could be readily taken out after the cope had been lifted off. The mold consisted of about 25 different parts. Special care was taken to provide for contraction in cooling and the mold was well-vented throughout. The mold was gated through the bottom flange at either end. The labor of three men working 12 weeks was required to finish the mold. This time included the making of rigging, plates and all of the shop work connected with the job.

After the cope had been lifted off, the pattern drawn and the sand thickness removed, the various sec-

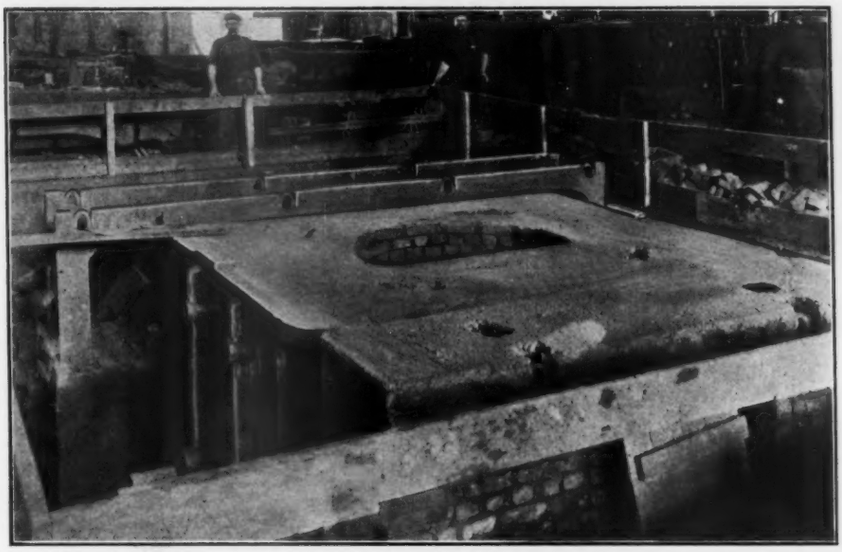


FIG. 5—A VIEW OF ONE SIDE OF THE CHEEK

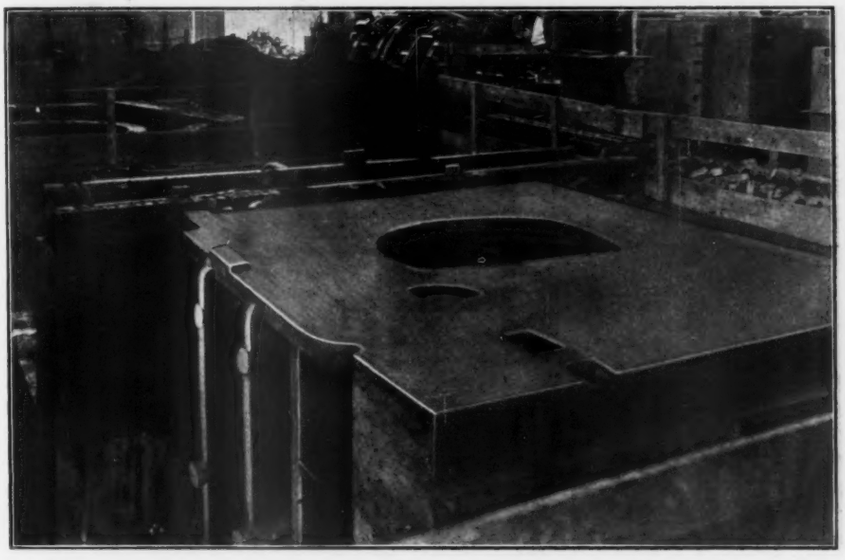


FIG. 6—TOP PLATE IN POSITION READY TO LIFT OFF ONE PART OF THE MOLD

FIG. 7—THE MAIN BODY CORE COMPLETED READY FOR THE OVEN

FIG. 8—THE CORE AFTER DRYING, REASSEMBLED IN THE MOLD

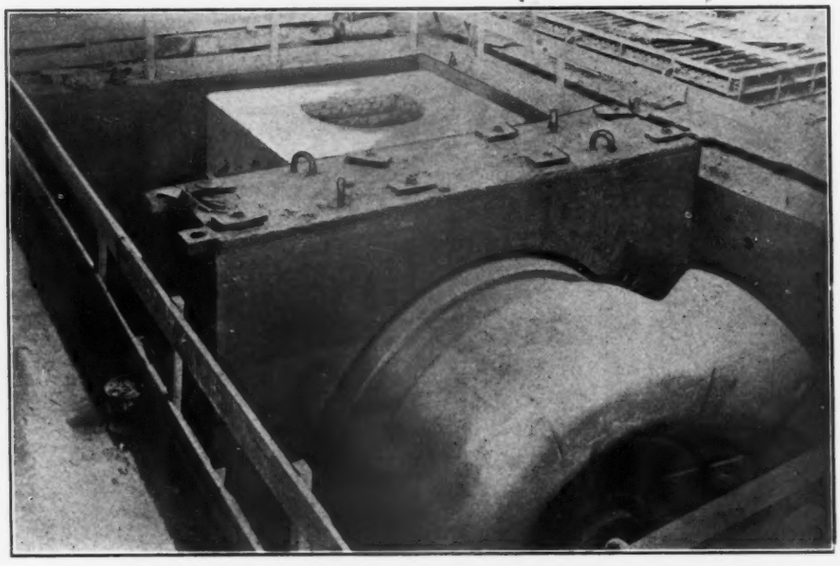


FIG. 9—A VIEW OF THE MOLD, SHOWING A SECTION OF THE COPE IN POSITION

FIG. 10—A VIEW OF THE TOP OF THE MOLD WITH THE TOP PLATE IN POSITION

tions of the mold were finished and dried. After drying, the mold was assembled again. A very heavy top plate was used to cover the mold and this was bolted to the bottom plate. Heavy binders were then placed across the top plate which were bolted to the bottom plate with rods passing through lugs at the sides of the top plate as shown in Fig. 11.

*Pouring the Mold*

The mold was poured at both ends by two ladles of 10 and 20 tons capacity each. The metal first entered the mold from the 20-ton ladles and after about one-half of its contents had been emptied, the 10-ton ladle was brought into service and the pouring was completed by the two ladles simultaneously. About 60,000 pounds of metal were used and the pouring operation required about 1¾ minutes. One 56-inch cupola was employed for melting the metal. The casting was allowed to remain in the sand about four days.

The handling and shipping of the casting proved quite a problem. A special, low type flat car had to be employed, as the casting was too large to pass under bridges on an ordinary car. Views of the casting loaded on the flat car are shown in Figs. 12 and 13. To prevent the casting from shifting on the car, it was held in position by chains attached to hooks fastened to the car sills.

## High Pressure Gas for Brass Melting

High pressure gas is finding extensive use in the brass foundries of Great Britain, and a number of furnaces have been patented for utilizing this fuel. One of the more recent types consists of a central melting chamber, surrounded by narrow annular spaces through which the products of combustion are made to circulate, and to which they give up some of their heat and thereby increase the temperature of the furnace.

It is doubtful whether this feature possesses any great value, as the partitions are necessarily thin, and being exposed to the heat on both sides, their life will be short, rendering frequent repairs necessary. At the bottom of the melting chamber is fitted a grate, on which the crucible stand is supported, and underneath the grate is the bottom of the furnace which is lined with firebrick dished to a central hole, so that spilled metal will pass through the grates and will run from the furnace through the hole. In order to prevent air

being drawn through this hole, it is fitted with a flap valve opening downwards, which is depressed by the weight of the leaking metal. The furnace is also provided with a heating chamber through which the gases pass on their way to the stack. This consists of a rectangular chamber fitted with a door in the side of the furnace, and its purpose is to preheat the ingot metal before it is charged into the crucible. The cover of the furnace swings sideways and is provided with a hole in the center over the crucible. A ring of refractory material fits into the hole in the furnace cover, being suspended by a flange on its upper end, while the other rests on the crucible, thus forming a hopper for the charge. The position of the burner is not given in the patent specifications, but it was doubtless set at a tangent to the circumference of the furnace. The distance from the center line of the burner to the bottom of the furnace should be 2½ inches for high pressure gas.

## English Brass Foundry Practice

In an address presented before the London Branch of the British Foundrymen's Association, entitled "Brass, Its Manufacture and Practical Applications," J. Edwards, of the Woolwich arsenal, emphasized the value of chemical analyses to brass founders and strongly recommended the purchase of all materials by specifications. The consumption of fuel, he stated, was largely dependent upon the amount of space allowed between the crucible and the walls of the furnace. A space of about 2 inches is good practice and results in an economy of fuel that is very marked. The furnace lining wears away rapidly for a space of about six inches from the bottom, due to the high temperature at that point. The life of the lining can be prolonged considerably, however, by occasional patching, a good mixture for this purpose consisting of one part of old fire bricks, two parts of old crucibles and two parts of fire clay. The ingredients should be pulverized, thoroughly mixed, moistened and worked into a thick mixture which should be applied to the burned-out part of the furnace. The yellow brass mixture in use at the Woolwich arsenal consists of copper, 70 per cent, and zinc, 30 per cent. It is charged as follows: Copper, 130 pounds; brass clippings, 132 pounds, and zinc, 68 pounds. The flux consists of 1 ounce of borax, 2 ounces of salt and 12 ounces of charcoal. This addition reduces the zinc oxide and prevents the vaporization of

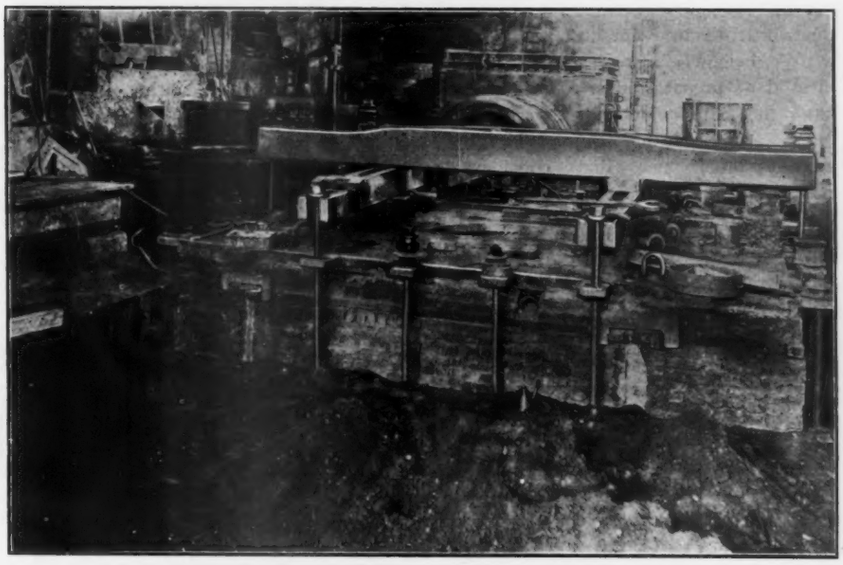


FIG. 11—THE MOLD CLOSED WITH THE BINDERS IN POSITION

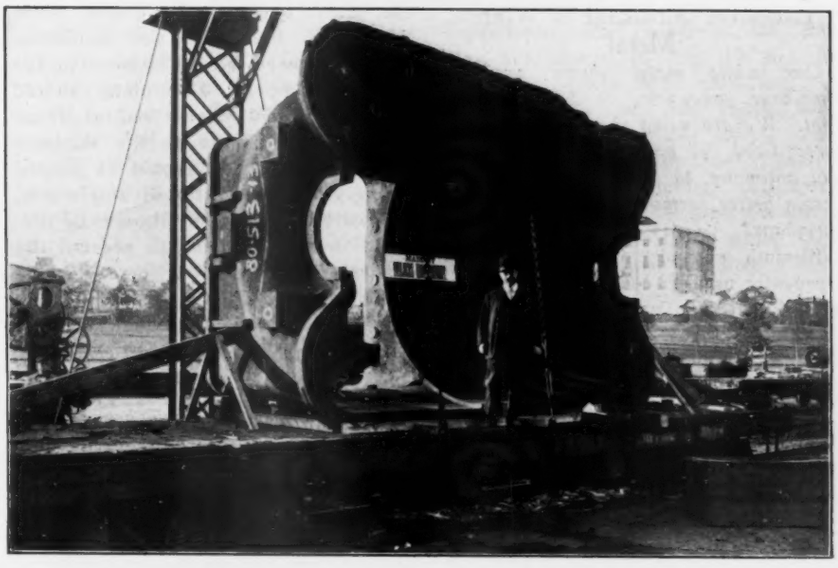


FIG. 12—INTERIOR VIEW OF THE CASTING ON THE CAR READY FOR SHIPMENT

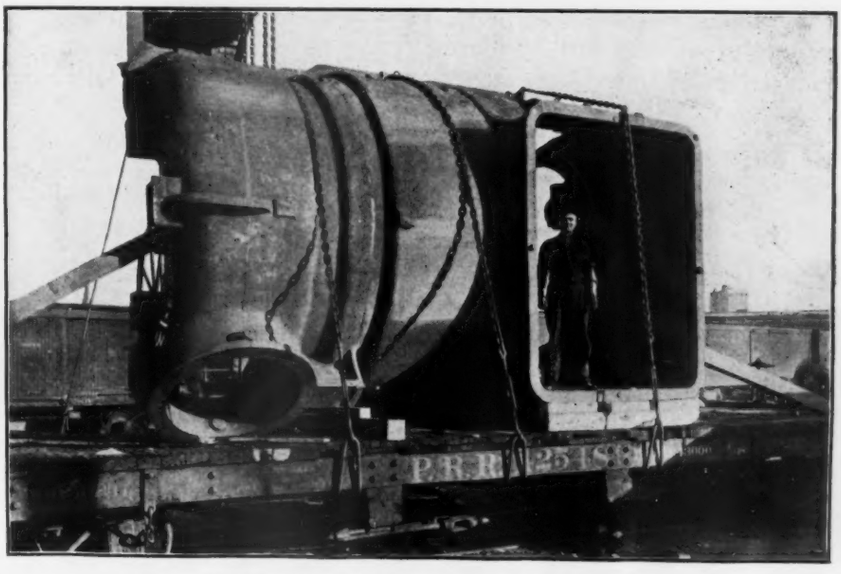


FIG. 13—EXTERIOR VIEW OF THE CASTING

the zinc. A large amount of the work at Woolwich is cast in chills and the method of preparation is to rub lard oil onto the chill which is covered with finely powdered plumbago. Mr. Edwards stated also that considerable economy can be effected by making the furnace flues sufficiently long so that the zinc oxide would be deposited therein, as this material gives a good return for the trouble of scraping it off, as it is used for making paint. The coke used in brass melting should not contain more than 5 per cent of ash and if also low in sulphur, is excellent fuel for melting with either cupola or shaft furnaces.

In the ensuing discussion, A. Willis stated that the bulk of the brass work in London is made under different conditions from those given by Mr. Edwards. Salt, as a flux, he considered bad, as it cuts the crucible and generates chlorine gas which is injurious to the workmen. He preferred the use of glass placed on the bottom of the crucible. Another member claimed that it was not necessary to add borax and salt if the metal is covered with charcoal while in the furnace.

# BRASS FOUNDRY DIFFICULTIES

## Solved by Experts

### Excessive Shrinkage of White Metal

*Our white metal shows excessive shrinkage, amounting to 3-64 inch per foot. We are using the following mixture: Lead, 10 pounds; tin, 5 pounds, and antimony, ¾ pound. Can you suggest a better formula that will eliminate shrinkage?*

Bismuth expands on cooling and is frequently used to counteract the shrinkage of pattern alloys. We would suggest in this case the substitution of bismuth for antimony in the formula given in order to reduce the shrinkage.

### Hard Phosphor Bronze

*For a number of years we have been using phosphor bronze plates 7-8 inch thick and 3 inches in diameter, which run in oil between two steel plates of the same dimensions. These plates are used on hoisting engines and must withstand great pressure without cutting while revolving. Recently the plates we have obtained from various sources have been very unsatisfactory, as they lacked uniformity and have been pitted. We, therefore, intend to make them ourselves and would like to obtain the formula for an alloy that will be hard, of high compressive strength and will possess anti-frictional qualities.*

The following formula is suggested: Copper, 81 pounds, 6 ounces; tin, 12 pounds, and 15 per cent phosphor-copper, 6 pounds, 10 ounces. This alloy will be found very hard and will withstand high compression. The compressive strength can be increased if found advisable by increasing the tin, and correspondingly decreasing the copper. The alloy should be made by melting the copper under a cover of charcoal, adding one-half of the phosphor-copper as soon as the metal becomes liquid and when thoroughly fluid, the tin should be added, followed by the balance of the phosphor-copper. The metal should be poured a dull cherry red, at which stage it will adhere to the skimmer to some extent. It should be poured strongly through gates of ample size, and careful attention should be devoted to the skimming to prevent the particles of slag from entering the molds.

### Mixture for Bronze Gears

*We would like to obtain a mixture suitable for making small bronze gear wheels. These castings are from four to ten inches in diameter and, as they have to withstand a great strain, they wear away very fast.*

We suggest the use of a gun metal of the following composition: Copper, 88 pounds; tin, 10 pounds; zinc, 2 pounds.

### Mixture for Bibbs and Globe Valves

*Will you kindly favor us with a mixture for bibbs and globe valves? At present we are using the following: Copper, 82 pounds; tin, 6 pounds; lead, 6 pounds, and zinc, 6 pounds. We desire a mixture that will produce castings of a bright red color.*

A mixture suitable for valves and bibbs follows: Copper, 88 pounds; tin, 4 pounds; zinc, 6 pounds, and lead, 2 pounds. The molds are dusted with flour, the castings are shaken-out of the sand hot and immersed in water. It will be found difficult to avoid getting a nice color on the castings if these instructions are followed and an alloy is used free from iron contamination.

### Suggestions for Casting Manganese Bronze

*We would appreciate a few suggestions regarding the casting of manganese bronze, with special reference to the control of the shrinkage, melting, temperature at which to pour and also the formula for an easy casting alloy. We also would like to receive advice on casting aluminum brass; we find that our castings run dirty at the gates when poured flat. The castings are thin and it would be more advantageous to pour them flat, but on account of the dross we find it necessary to run them upright.*

In order to obtain satisfactory manganese bronze castings, it is necessary to use large and heavy risers on all parts where shrinkage is liable to occur, and to obtain clean castings they are usually poured from the bottom by means of a long runner, so designed that the metal will fill the mold as quietly as possible. Manganese bronze may be compared with soapy water; agitation produces froth or suds, which, in the case of the metal means dross in the castings, as the froth never subsides before the metal solidifies. Melt the metal under a cover of charcoal, with the addition of a little salt, and pour at a temperature so low that the metal does not smoke. The following alloy may be used: Copper, 55 pounds; zinc, 36 pounds; aluminum, 5 ounces; tin, 5 ounces, and manganese-copper, 5 pounds. If you can get along without lead in your brass, the use of silicon-copper in place of aluminum will overcome your difficulty, but if lead is necessary you will have to use aluminum, and we can suggest no manner in which the trouble can be overcome, except by the use of long runners.

# Layout and Construction of a Modern Foundry

*Description of the Taylor & Boggis Foundry Co.'s new plant—Well-arranged sand blast department*

PROGRESS in the construction of foundry buildings, in recent years, compares favorably with the advancement recorded in the manufacture of castings and practically all shops that are being built are designed to reduce the fire risk to the minimum. Lighting facilities and ventilating and heating arrangements also have received careful consideration and the modern casting plant affords every convenience for the health and welfare of the employes. Steel is employed almost exclusively in the framework with brick or concrete applied to metal lath for the curtain walls. The sides and ends of the buildings consist largely of glass set in metal sash and while various forms of roof construction have been adopted, all are designed to admit an overhead light and are equipped with ventilators of sufficient area to carry off the smoke and gases. The roofing material used, whether tile, concrete or of a prepared type, is fire resistive and the structures throughout are practically fireproof.

The new foundry of the Taylor & Boggis Foundry Co., Cleveland, together with the auxiliary buildings and departments, embody all of the best features of modern manufacturing plant design and construction. Steel, brick, concrete and glass are the materials employed in the erection of the various structures and with the exception of the sand and coke sheds no wood was used for building purposes. The foundry is 110 feet wide and 420 feet long, being divided into three bays, 30, 50 and 30 feet wide, respectively. The roof over the middle bay is in the form of a monitor, the sides consisting of two rows of continuous windows, the upper rows being hinged and serve as ventilators. To the peak of the roof over the middle bay the building is 38 feet high and the lowest point of the side bays is 28 feet above the floor. The sides and one end of the building, above a brick curtain wall, 4 feet, 9 inches high, consist of glass in rolled steel sash with ventilators in every section. The roof over the middle and side bays is made of concrete with metal reinforcement and is covered with a composition which contains a high percentage of Trinidad asphalt and this is covered with a layer of crushed slag. All of the glass in the windows and ventilators is translucent and a large percentage is wired, the large window area affording an abundance of natural light. The end of the foundry adjoining the office building is of brick construction and the gable, which rises above the office, contains a number of wire glass windows. The opposite end of the foundry is formed of continuous sash to a height of 14 feet above the curtain wall. Above this, with the exception of a continuous row of windows in the monitor, 6 feet high and 48 feet long, the building is enclosed with concrete plaster applied to sheet metal reinforcement. End views of the foundry are shown in Fig. 13 and Fig. 14 is a broken side elevation. An interior view of the shop, which clearly illustrates the ample lighting facilities and the roof construction over the middle bay, is illustrated in Fig. 2. Fig. 4 shows a section of one of the side bays, which is devoted to snap flask molding machine work.

The Taylor & Boggis plant, which is devoted to the manufacture of gray iron castings and builders' hardware, is located at the intersection

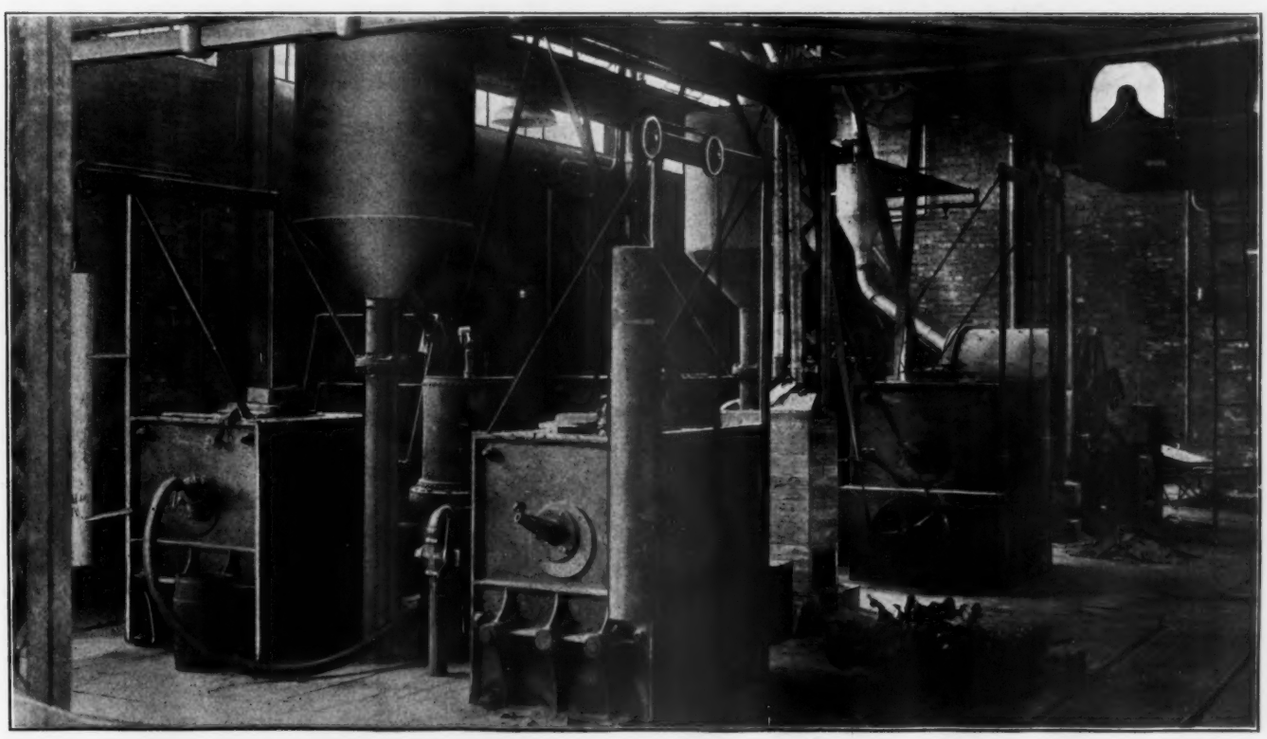


FIG. 1—SAND BLAST TUMBLING BARREL EQUIPMENT IN THE TAYLOR & BOGGIS FOUNDRY

FIG. 2—GENERAL VIEW OF THE TAYLOR & BOGGIS FOUNDRY

of East Fifth-fifth street and Belford avenue. The foundry extends along Belford avenue and the hardware department parallels East Fifty-fifth street. The end of the foundry extends to a point 50 feet from East Fifty-fifth street, overlapping only 60 feet of the end of the hardware department. In the angle thus formed, the office building is located with its longer dimensions parallel with and adjoining the end of the foundry. The office building is divided from the hardware department by a driveway which leads to the shipping and receiving platform of both the foundry and the hardware department. These platforms are located in a covered yard formed by enclosing the space between the side of the foundry and the end of the hardware building. In the angle formed by the main buildings are located the auxiliary departments, including the power plant, pattern storage, sand and coke bins and the lean-tos to the foundry, which contain, respectively, the cupola room and weighing shed, core department, core ovens and the japanning room and ovens.

The middle bay of the foundry is served by a 10-ton traveling crane, installed by the Northern Engineering Works, Detroit, and by a two-ton jib crane furnished by the Euclid Crane & Hoist Co., Euclid, O. The jib is of the detachable type and can be attached to any column, being conveyed to various points throughout the shop by the traveling crane. To facilitate the handling of castings and foundry material generally, an industrial railway extends along both sides of the middle bay and across both ends of the shop, turntables being conveniently located for the delivery of castings

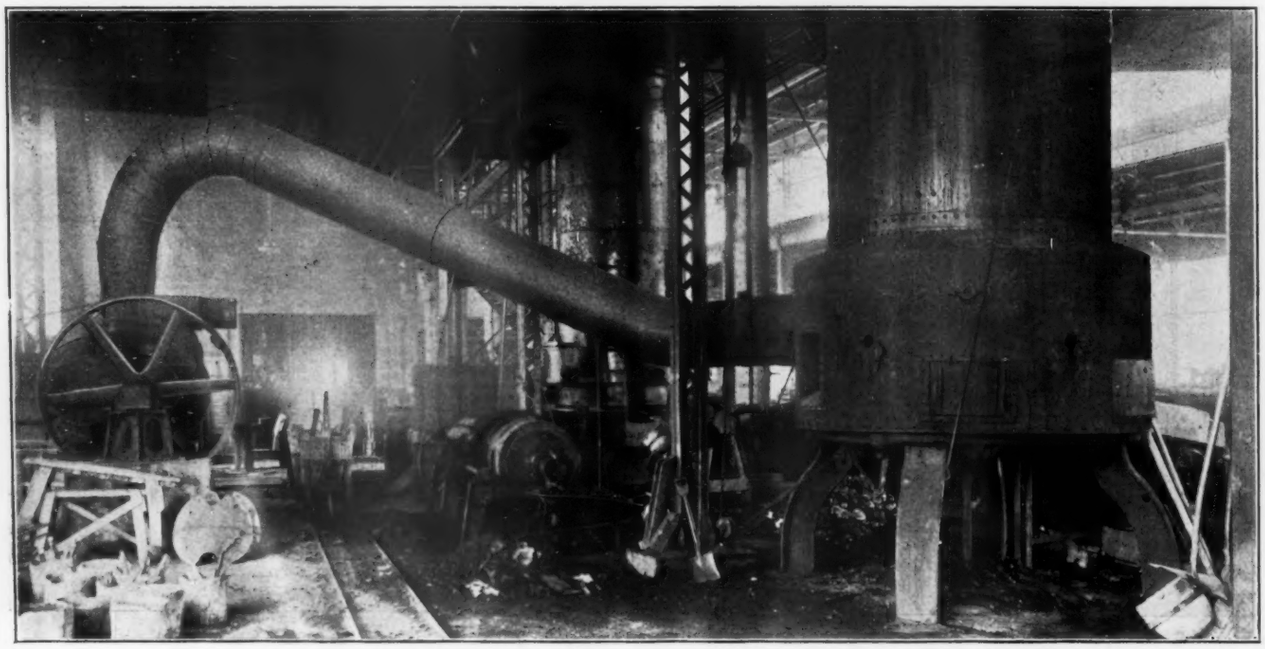


FIG. 3—VIEW OF THE CUPOLAS, SHOWING THE CINDER MILL AND BLOWER

FIG. 4—A VIEW OF A SECTION OF ONE OF THE SIDE BAYS

to the cleaning and other departments.

At one end of the foundry a mezzanine floor has been erected to a height of 17 feet. This floor is entirely enclosed, separating it from the foundry, and extends across the end of the middle bay, being 20 feet wide at this point and 60 feet long over the side bays. A large door opens onto a landing stage projecting from the mezzanine floor which permits of the delivery of the material from the middle bay of the foundry to the mezzanine floor and it is also utilized for delivering large flasks by crane from the flask-making department to the foundry. One side of the mezzanine floor is used as a lumber storage for the pattern shop and flask department and on the opposite side are located the exhaust fans, motors, etc., for the sand blast equipment. A ground plan of this mezzanine floor is illustrated in Fig. 15, which clearly shows the loading platform commanding one end of the foundry, as well as the exhaust fans, pipes, etc., for the sand blast equipment.

*Melting Equipment*

The two cupolas are located in one of the side bays at the center of the length of the shop. Below the charging floor they are not enclosed, as illustrated in Fig. 3. To facilitate the recovery of iron and coke from the cupola drop, a cinder mill has been installed between the furnaces, thereby reducing the handling of this material, which is necessary when the mill is located in some corner of the shop or outside of the foundry. The fan and blower are located directly in the rear of the cupolas and only short blast pipes are required. A plan view of the cupola room underneath the charging floor is shown in Fig. 16, which also contains an end elevation and section of the charging floor.

From the foundry an iron stairway leads to the charging floor which is 50 x 60 feet, and was installed and equipped by the Whiting Foundry Equipment Co., Harvey, Ill. A plan view of this floor, showing the storage tracks for coke and iron and three depressed tracks at the

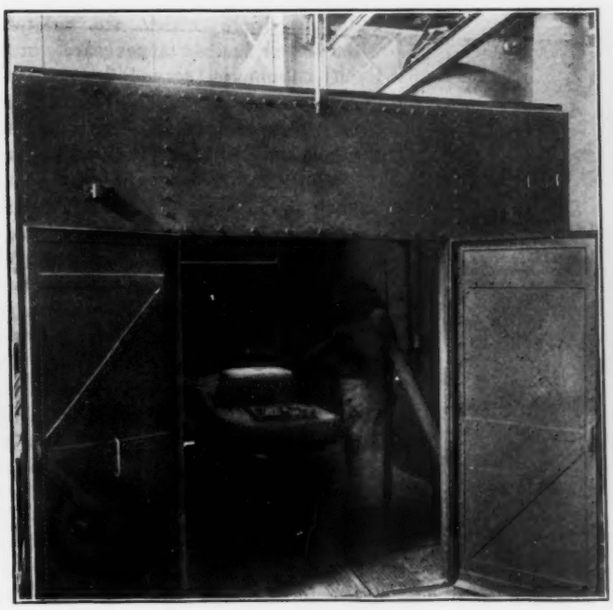


FIG. 5—THE STEEL PLATE SAND BLAST ROOM

FIG. 6—THE MECHANICAL CUPOLA CHARGING DEVICE

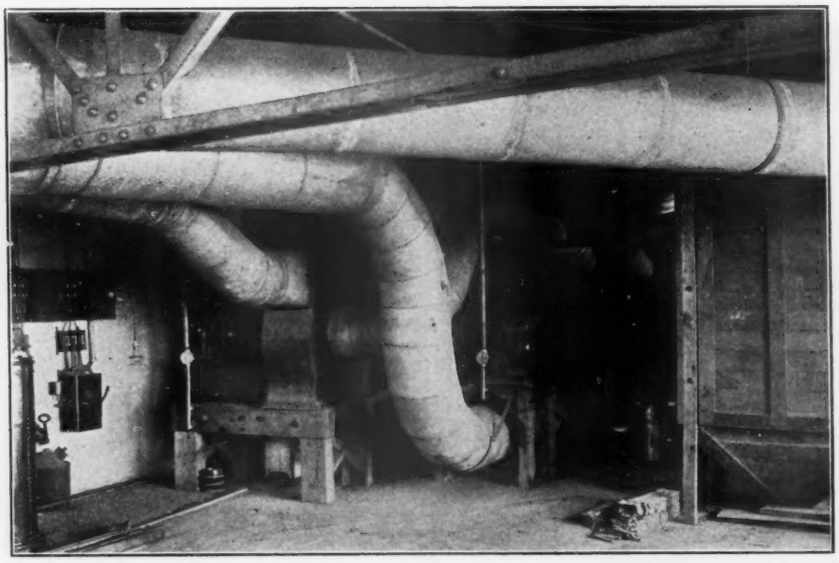


FIG. 7—EXHAUST FANS, SEPARATORS AND WASHERS FOR THE SAND BLAST EQUIPMENT

FIG. 8—THE SAND BLAST ROOM, SHOWING THE GLASS ROOF

FIG. 9—A GENERAL VIEW OF THE CLEANING DEPARTMENT

sides and in the center is illustrated in Fig. 17. The floor has capacity for 64 cars and the gage of the tracks is 21½ inches. The charges are made up in the weighing room underneath the charging floor and are delivered to the charging floor by two elevators of 4,000 pounds capacity each. These elevators connect with the depressed track on either side of the charging floor and the cars are delivered to the storage tracks by turntable transfer buggies. The depressed tracks are 4 feet, 6 inches wide and extend the length of the charging floor. A third depressed track extends through the center of the floor and facilitates the movement of the charging cars to and from the cupolas.

### *Mechanical Charging Equipment*

A view of the charging floor is shown in Fig. 10, which clearly illustrates the depressed track in the center of this floor and shows the charges of iron, scrap, etc., as delivered from the weighing room. On the transfer buggy is a car of anthracite coal which is of the same type as used for conveying coke to the charging floor. To facilitate the charging of the cupolas air hoists are employed which discharge the contents of the pig iron and scrap cars and the fuel buggies by elevating one end of the cars. When the contents of a car are to be discharged into the cupola the car is moved onto a platform directly in front of the charging door. After the car has been locked to the platform air is admitted to the hoist and one end of the platform is raised, as illustrated in Fig. 6. The ends of the coke buggies are equipped with swinging doors which are unlatched when the fuel charges are made. Each cupola is served by two air hoists which permits of charging from both sides to distribute the charges uniformly. The cupolas are, respectively, 78 and 84 inches in diameter. In Fig. 6 at *A* is shown a sheet steel door which is placed over the charging door immediately after the fire is lighted. It has been found that this type of door materially increases the draft as compared with the door of the screen type with which cupolas generally are equipped. These furnaces have doors of both types, the screen being employed after the blast is on. The large cupola is driven by a Connersville positive pressure blower and the blast for the 78-inch furnace is furnished by a Sturtevant fan. Both blowers are motor-driven. The cinder mill, which

is 34 x 40 inches, was installed by the Cleveland Nickel Works, Cleveland.

The cleaning department is located at the end of the shop adjoining the office and, as shown in the ground plan, Fig. 18, the grinders are located at one side and the sand blast equipment on the opposite side with the chipping stands between these two departments. A general view of the cleaning floor is shown in Fig. 9, which illustrates the chipping benches, steel plate sand blast room and the sand blast tumbling barrels in the background. At the left are two screens which have been erected to safeguard the employes of the cleaning department from flying chips. Chippers are located on either side of these screens. Industrial railway tracks serve all sections of the cleaning floor. Pneumatic chippers are employed, the air being taken from upright pipes close to the screens.

*Sand Blast Equipment*

The sand blast equipment is unusually complete and consists of five sand blast tumbling barrels and one sand blast room for cleaning large castings. Provision has been made also for the installation of another room of this type. A view of the sand blast tumbling barrels is shown in Fig. 1. The equipment is belt-driven by a motor on a platform at one end of this department. The separators, blowers and exhaust fans are on the mezzanine floor, as illustrated in Fig. 7. The fans are all driven by individual motors. The steel plate sand blast room is illustrated in Figs. 5 and 8. It will be noted that an extension from the industrial track passes through the center of this room, which is provided with double doors at either end. Castings are delivered to this room on flat cars and after being sand-blasted are conveyed to the cleaning room for subsequent chipping operations. The floor is perforated and the sand falls into a hopper from which it is exhausted and after being cleaned and separated is again delivered to the sand blast room for further use. The lighting of this room is unique and being entirely enclosed with steel plates on its four sides, light is admitted through the roof, which consists of glass. It will be noted in Fig. 8, which clearly shows this roof construction, that four electric lamps are suspended above the roof so as to reflect their rays directly into the sand blast room. Four of the sand blast tumbling barrels, as well as

FIG. 10—THE CUPOLA CHARGING FLOOR

FIG. 11—PLATING ROOM IN THE HARDWARE DEPARTMENT

FIG. 12—ONE OF THE CEMENT WATER TROUGHS

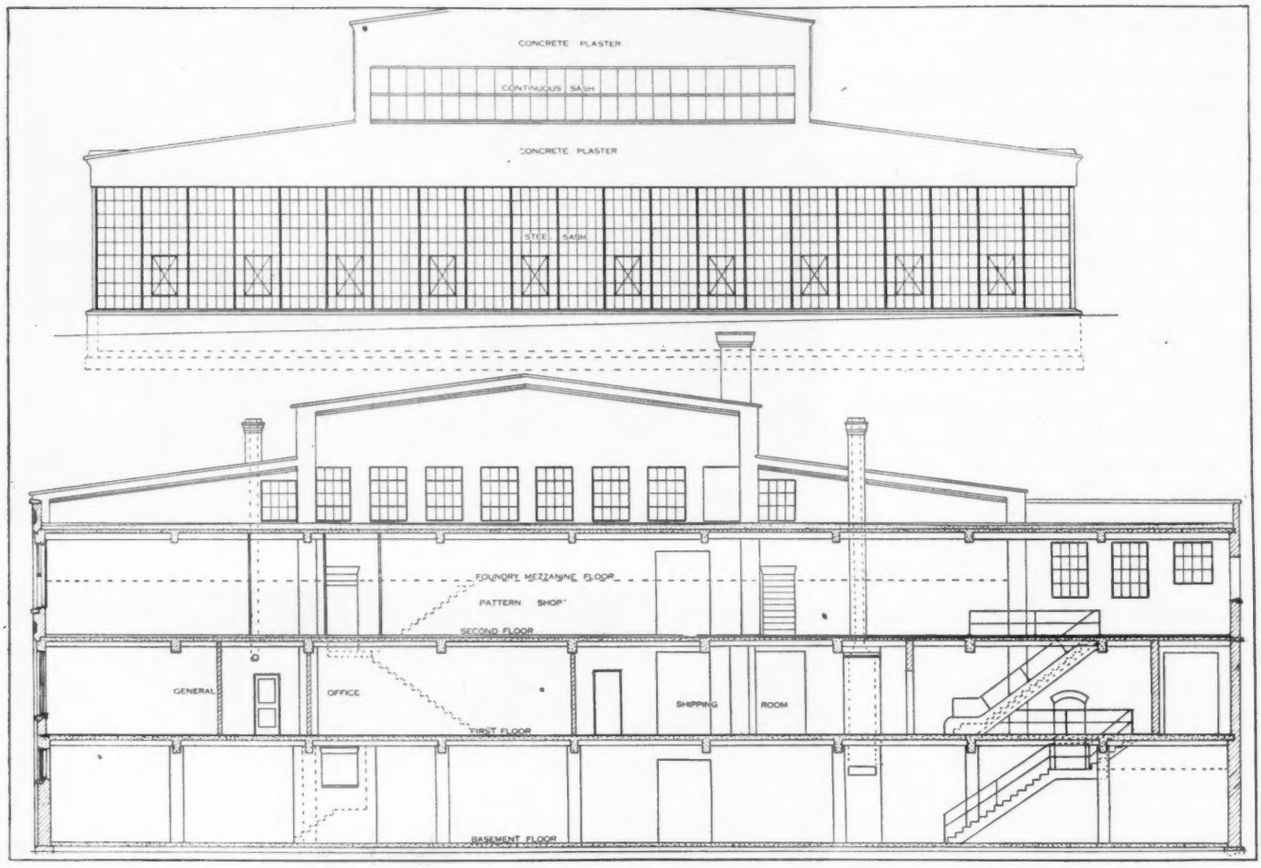



FIG. 13—ELEVATIONS OF THE ENDS OF THE FOUNDRY BUILDING

the sand blast room, were installed by the Tilghman-Brooksbank Sand Blast Co., Philadelphia, and one sand blast barrel was furnished by the New Haven Sand Blast Co., New Haven, Conn.

The mechanical molding equipment comprises 39 machines, 30 of which are of the squeezer type designed and built by the Taylor & Boggis company. In addition there are six 10-inch power ramming machines and one shockless jar-ramming machine, installed by the Tabor Mfg. Co., Philadelphia; one combination squeezer installed by the Berkshire Mfg. Co., Cleveland, and one stripping plate machine, built by Henry E. Pridmore, Chicago.

The core department occupies an area 30 x 80 feet and is equipped with one jar-ramming coremaking machine, installed by the Osborn Mfg. Co., Cleveland. The core ovens installed by the J. D. Smith Foundry Supply Co., Cleveland, consist of a battery of four rolling drawer ovens and one car oven, 20 x 38 feet. All of the ovens are fired with natural gas.

The pattern shop is 50 x 135 feet, and is located on the second floor of the office building. Both wood

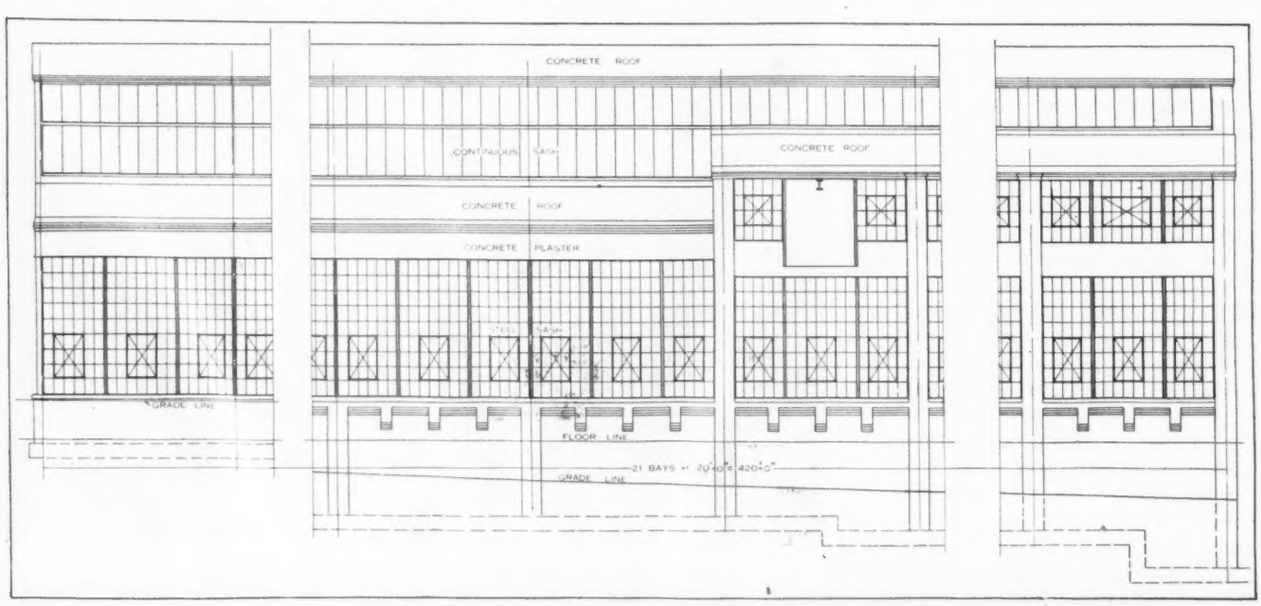



FIG. 14—BROKEN SIDE ELEVATION OF THE FOUNDRY

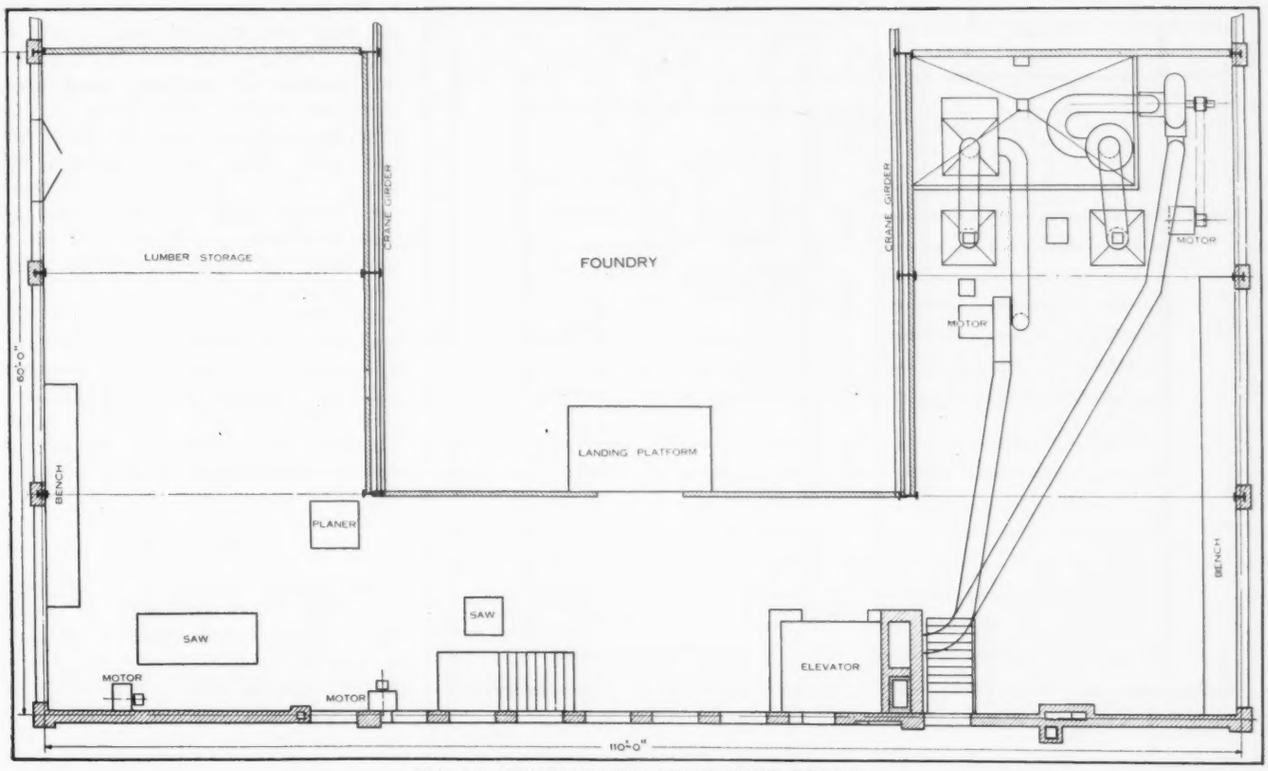



FIG. 15—PLAN OF THE MEZZANINE FLOOR

and metal patterns are made and the equipment consists of the usual pattern shop machinery necessary for such operations. The foundry locker rooms and lavatory are in the basement of the office building in a room, 45 x 50 feet. A total of 215 lockers have been installed, as well as 30 wash bowls, hot water being provided by instantaneous heaters. Provision also has been made for the installation of shower baths.

The japanning room adjoins the core department and is divided off by concrete walls. The floor is made of cement and is 6 inches lower than the other floors of the shop. The tops of the ovens are provided with

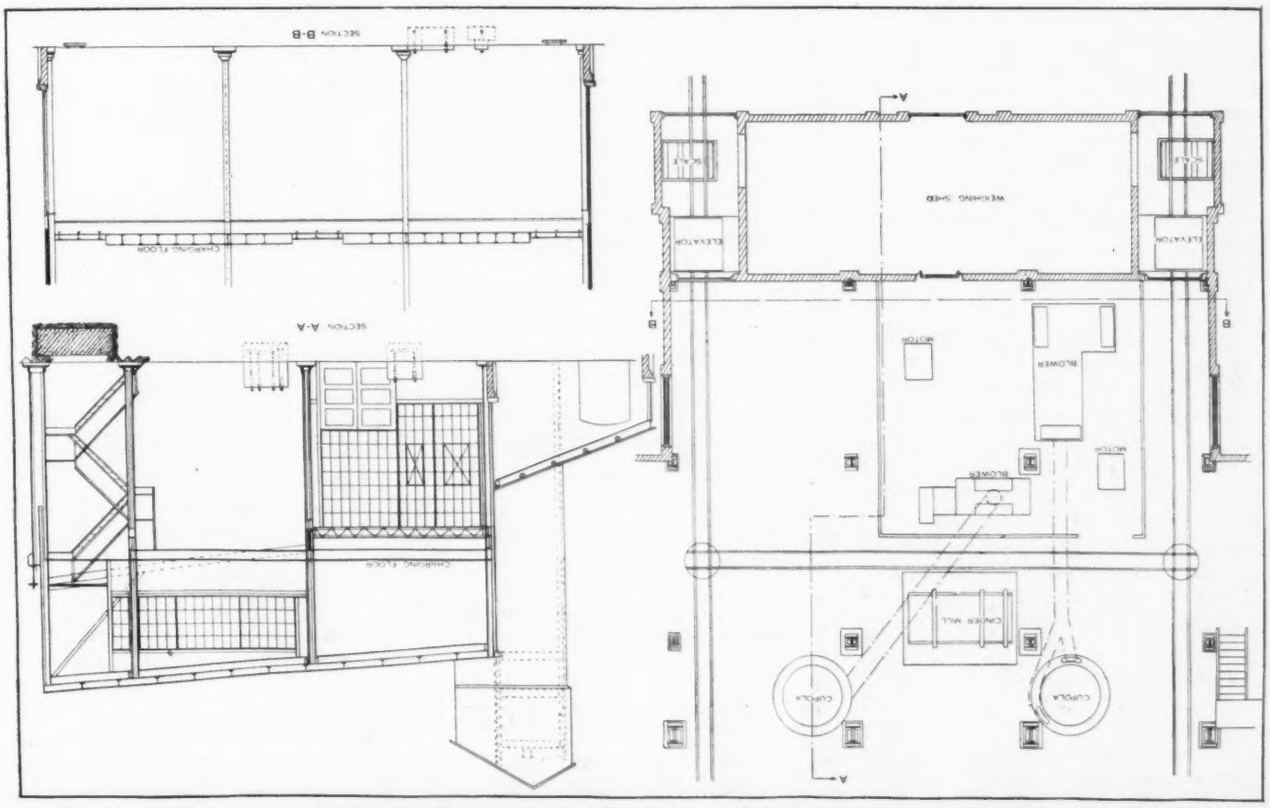


FIG. 16—PLAN OF THE CUPOLA ROOM AND SIDE ELEVATION AND SECTIONAL VIEW OF THE CHARGING FLOOR

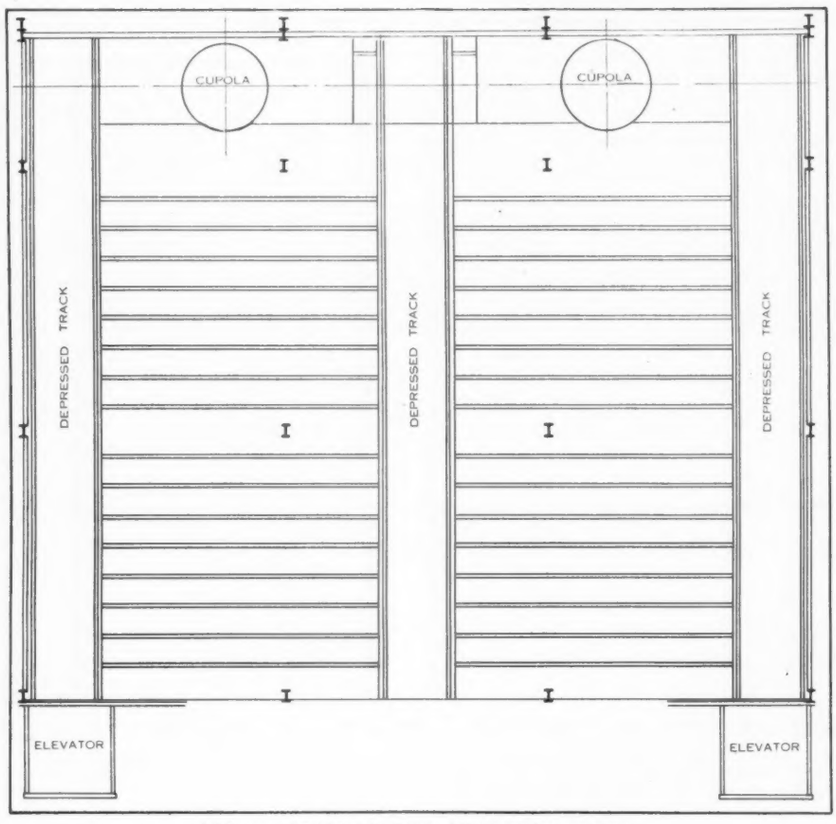



FIG. 17—PLAN OF THE CHARGING FLOOR

four doors, which, in the event of an explosion, will open and will thereby prevent damage to the ovens. The mixing tank is made of cement and extends below the floor level with inclined troughs at either end.

The foundry is steam heated by pipes suspended 12 feet above the floor and 30 inches from the sides of the building, as shown at *A*, Fig. 4. In the pattern shop and offices stamped steel radiators have been installed, which are suspended from the walls directly underneath the windows.

### *Fire Protection*

In the foundry a unique system of fire protection has been provided. Water pipes are suspended from the columns which support the center bay, as illustrated in Fig. 19, and at various points throughout the shop hose and nozzles are attached which almost extend to the foundry floor. These outlets are so distributed throughout the shop that every part of the foundry can be commanded in case of fire. Underneath each hose is a cement water trough which replaces the usual unsightly foundry water barrel. These troughs are supplied with water from the overhead main. The troughs are 2 feet wide, 4 feet long and 2 feet, 10 inches deep. They are conveniently distributed throughout the shop, near the center columns. One of these troughs is illustrated in Fig. 12 and it will be noted that it serves sections of both the light and heavy work floors.

The coke and storage bins are 30 x 200 feet. The walls are brick and the bins are covered with a gravel roof. These bins are divided for the storage of molding sand, core sand and coke. The floor of the coke bin is level with the yard, but the sand bins are excavated 42 inches below the yard to increase the storage space. The sand and coke is discharged from cars on a side track at one side of the bins and on the opposite side is an industrial railway track over which the material is delivered to the foundry. The pattern storage is a detached building constructed of brick and steel and provided with wire glass windows. It is heated by steam coils and is equipped with shelves throughout.

### *Power Plant*

The power house is a detached brick and steel structure, 50 x 98 feet. Steam for heating is generated by three boilers of 100 horsepower capacity each. The coal is discharged direct from hopper bottom cars into bins at the side of the boiler house. The electrical equipment consists of a 150-horsepower General Electric motor, which drives a twin-cylinder air compressor of 1,350 cubic feet capacity per minute at 35 pounds pressure. This compressor furnishes air for the sand blast equipment. The two-stage high pressure air compressor has a capacity of 450 cubic feet of air per

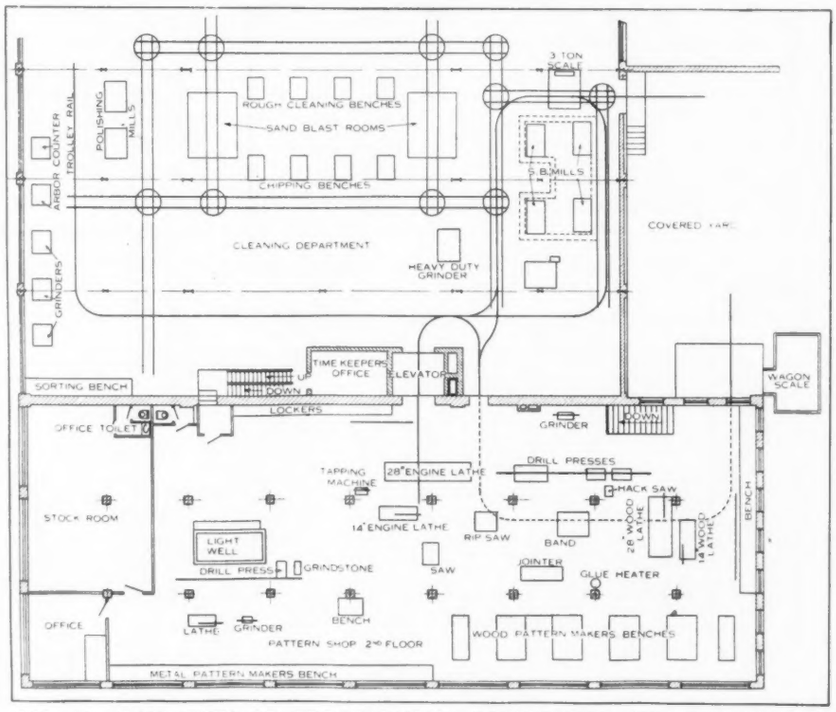



FIG. 18—PLAN VIEW OF THE CLEANING DEPARTMENT AND THE PATTERN SHOP, WHICH IS LOCATED ON THE SECOND FLOOR OF THE OFFICE BUILDING

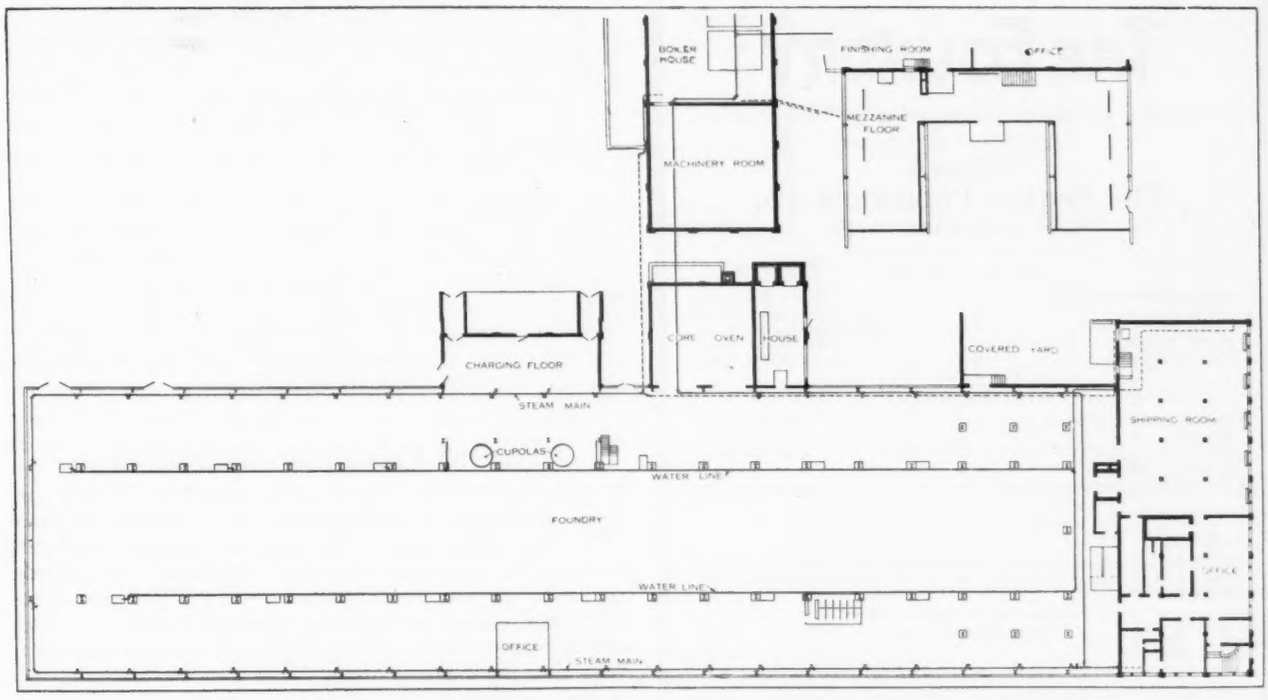



FIG. 19—PLAN VIEW OF THE FOUNDRY, SHOWING THE STEAM AND WATER MAINS

minute and furnishes air at 100 pounds pressure for the molding machines, chipping hammers and the air hoists on the charging floor. At the present time the electric current is purchased, but space has been reserved in the power house for the installation of an engine and generator.

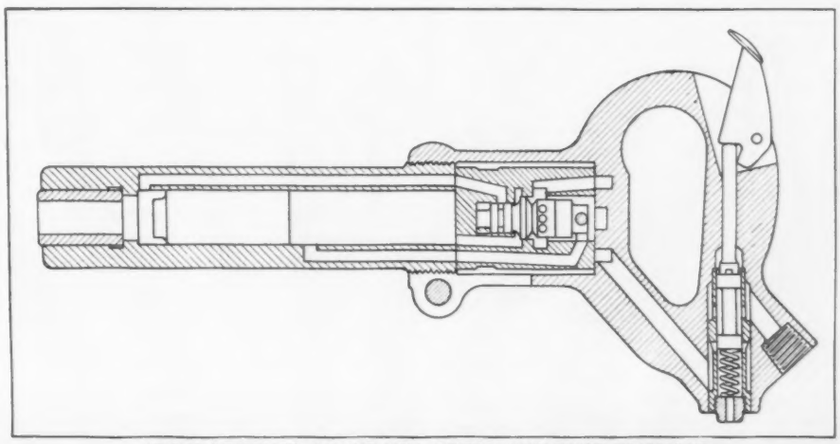
## Pneumatic Hammer for Chipping Steel Castings

A pneumatic hammer manufactured by the Pittsburgh Pneumatic Co., Canton O., particularly designed for chipping steel castings, is shown in the accompanying illustration. The throttle valve, as shown in the cross-section, is of the balanced piston type, and if it becomes worn after long usage any leakage from the hammer, when not in use, escapes into the atmosphere instead of into the hammer. The tool is so constructed that recoil is almost entirely eliminated. A feature of the construction is in the piston which is of the same length for hammers of various sizes, making it unnecessary to carry various sizes of pistons in stock, when more than one size hammer is used. The handle is a drop forging, the cylinder is made of alloy steel and the valve, valve block and throttle valve are made of high-grade steel, specially treated. This hammer is made in three sizes weighing respectively, 16½, 17 and 17½ pounds.

## New Installations of Foundry Equipment

The J. D. Smith Foundry Supply Co., Cleveland, has installed all of the foundry equipment in the new brass and aluminum foundry operated by the King Bronze & Aluminum Co., Cleveland, and in the brass foundry of the Iceless Refrigeration Co., of the same city. A contract has also been received for the installation of all of the foundry equipment in the plant of the United Foundry & Machine Co., Bridgeport, Conn. A large battery of rolling drawer core ovens is being built for installation in the Michigan Malleable Iron Co.'s shop, Detroit, and a second installation of core ovens is being made in the foundry of the M. Rumely Co., Battle Creek, Mich. Core ovens, coke and aluminum furnaces, together with cranes, have been furnished the American Car & Ship Hardware Co., New Castle, Pa., and the installation of a large number of core ovens at the Detroit and Cleveland plants of the Aluminum Castings Co. has been completed recently.

The Rockwell Furnace Co., New York City, has established an office in the Engineers building, Cleveland, for the sale of heat-treating, annealing, tempering and melting furnaces. This office will be in charge of George B. Norcross, who will have associated with him Walter F. Johnson, formerly assistant treasurer of the King Bridge Co., Cleveland, and E. W. Saunders, formerly of the Carbon Steel Co., Pittsburgh.



CROSS-SECTION OF HEAVY DUTY CHIPPING HAMMER

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## *Trade Outlook*

MEASURED by the increased volume of business reported by the supply houses and the scarcity of molders and common labor, the foundry business is practically on a normal basis. In a few isolated instances the tonnage is below capacity, but this is limited to the shops specializing in machine tool castings, notably in the New England states and in the Cincinnati district. The continuation of the present activity is foreshadowed by the large volume of business that is being placed with the casting shops. In the leading centers No. 2 foundry iron is quoted as follows: Pittsburgh, $14.15; Chicago, northern, $14.50; Philadelphia, $15; Cleveland, $13.75, and Birmingham, $11 to $11.25.

## *Accident Prevention in Foundries*

UNTIL a very recent date, accident liability in all industrial enterprises was measured by dollars and cents. Protection against damages assessed by reason of injuries to employes was afforded by employers' liability insurance and the premiums were considered a necessary overhead charge. The moral responsibility of the employer to the workman, however, could not be denied and a more humanitarian method is now being pursued, which is summed up by the old saw—"An ounce of prevention is worth a pound of cure". The prevention of injuries and fatalities among industrial workmen has received careful consideration, notably in the steel trade, and the good results achieved have led to the adoption of safety devices in many casting plants. A large steel foundry combine, about a year-and-a-half ago, decided that the number of accidents in its shops could be materially reduced by safeguarding its equipment, and in addition, great economies in accident claims could be effected thereby. After a careful investigation, it was found that accident prevention could, in a large measure, be attained by the proper design and construction of plant and appliances; care on the part of employers and employes and the use of safety devices. An effective working organization for safety work was perfected consisting of committees at each plant with a supervising safety inspector in charge. It was found, after careful investigation, that probably 75 per cent of the accidents in steel foundries affect the eyes of workmen. It became apparent, at the start, that it was necessary to supply with goggles, all grinders, chippers, blasters, ladlemen, etc. Some of the workmen refused to wear the goggles furnished, and to compel their use the workmen were requested to sign contracts agreeing to wear goggles constantly while at work, otherwise the company would be free from responsibility in the event of an accident. Another means of protecting workmen while cleaning castings consists of canvas screens, mounted on supports, which are placed between the men while at work. All emery wheels over 8 inches in diameter are tapered ¾ inch per foot and are protected with safety collars. Steel hoods also are provided, as well as plate glass shields to protect the eyes. To check up the speed limits of all emery wheels, tests are made every week by the safety inspectors. Sand-blasters are protected with helmets and respirators and arc-welders with aluminum helmets and rubber aprons, covered with asbestos. To prevent the feet from being burned, all workmen are urged to wear congress shoes and a supply is kept at all plants which are furnished to the men at cost.

# Equipment for the Foundry and Pattern Shop

***Combined Jar-Ramming, Pattern Drawing and Squeezer Molding Machine — Core Box Plane — Core Oven — Scratch Brush — Pneumatic Rammer***

A COMBINED jar-ramming, pattern-drawing and squeezer molding machine has been added to the extensive line of foundry labor-saving equipment manufactured by the Herman Pneumatic Machine Co., Zelienople, Pa. This machine, as shown in the accompanying illustrations, is especially designed for duplicate work, the jarring principle being employed for ramming the mold and subsequent butt-ramming is eliminated as the mold is squeezed automatically after the completion of the jar-ramming operation. The size of the table plate is 16 x 18 inches and the pattern draft 8 inches.

The pattern and stripping plates are attached to the table plate of the machine, the stripping plate being placed over the pattern and rests on the pattern plate. The flask is placed on the stripping plate and when air is admitted to the cylinder the mold is jar-rammed. In Fig. 1 the machine is shown with the squeezer head thrown back, in position to receive the flask. After the mold has been jar-rammed and the bottom board adjusted, the squeezer head is swung forward over the mold, as shown in Fig. 2. Air is admitted to the cylinder, thereby raising the table plate carrying the mold which is pressed against the squeezer head and the sand in the top of the mold is squeezed, thereby eliminating butt-ramming by hand.

In Fig. 3 the squeezing operation is clearly indicated. This view shows the table plate raised while squeezing the mold. Immediately after this operation the lever at the right of the machine is pulled forward and actuates the side lifting forks which move upwardly and engage the stripping plate, as shown in Fig. 4. When the air is discharged from the cylinder the table plate together with the pattern which is fastened to it, descend, thereby drawing the pattern from the mold through the stripping plate. The squeezer head is then thrown back and the flask is ready to be carried to the floor. The side lifting forks, which support the stripping plate are then lowered and the machine is in position for making another mold, as shown in Fig. 5. In the foreground of this view is a snap flask mold made on this machine.

After the mold has been squeezed the pattern can be drawn either through the stripping plate or by pulling the lever forward the flask can be stripped from the pattern. By this arrangement two different methods of drawing the pattern are provided. The machine is equipped with a differential control valve entirely enclosed to protect it from the sand. When jar-ramming the mold the table plate contacts with a series of rubber and steel discs on the base of the machine. These are illustrated in Fig. 3, which shows the table plate raised while squeezing the mold. This machine, which is adapted for snap flask work, can be furnished with table plates of any desired size and various depths of pattern draft.

## Protection for Foundry Employees

The June meeting of the Chicago Foundrymen's Club was held Saturday evening, June 8, at the Great Northern Hotel, Chicago. The subject discussed was the "Prevention of Accidents in Foundries" and a number of novel devices were described. Eugene Smith of the Crane Co. made a point which was very well taken, in that factors of safety are in the majority of cases also effective factors of economy and that savings to life and limb are accompanied in an equal degree by savings in dollars and cents. The principal points under discussion were ways and means to prevent spilling of iron from the ladles and devising supports for drying that are at once of a sufficiently light weight to be easily shifted and capable of sustaining weight. The dangers to workmen in cleaning the cupolas were also discussed and protection strongly advocated, the methods advised being

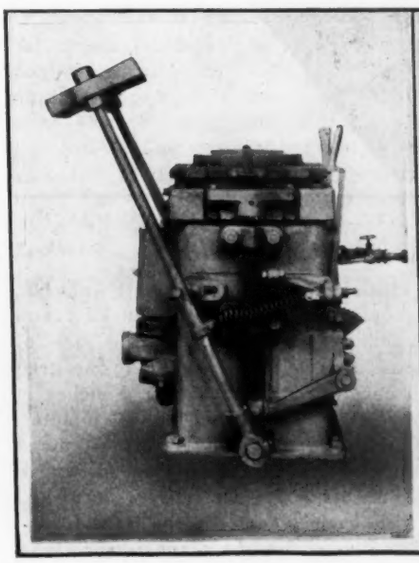


FIG. 1—COMBINED JAR-RAMMING, PATTERN-DRAWING AND SQUEEZER MOLDING MACHINE

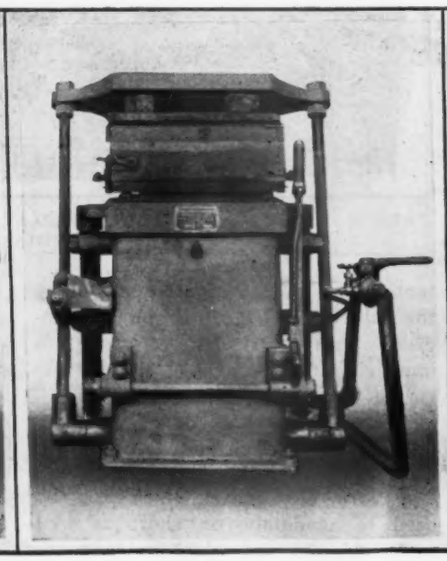


FIG. 2—MOLD RAISED, READY FOR SQUEEZING OPERATION

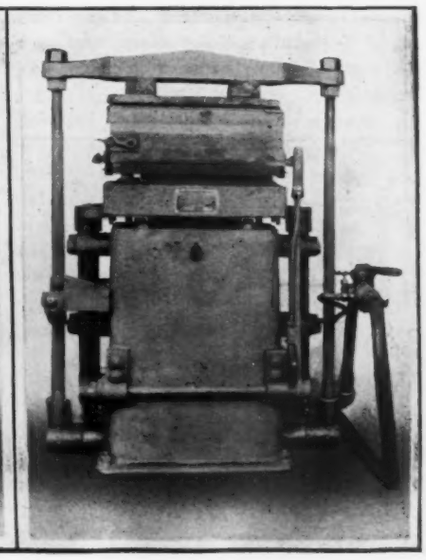


FIG. 3—TABLE PLATE RAISED IN SQUEEZING POSITION

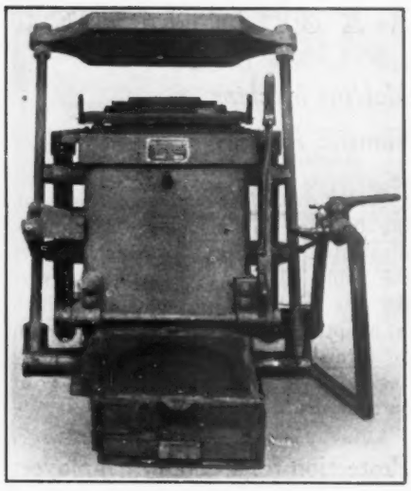


FIG. 4—TABLE PLATE LOWERED TO STRIP PATTERN FROM MOLD

the use of a circular screen hinged in the middle to fit in the cupola above the workmen and which, when folded, can be taken in through the charging door. It was also advised that a screen of about ¼-inch mesh be suspended between the workman who is handling the ladle and the molten metal. A screen of this character protects the workman's eyes from the danger of sparks and also serves as a protection against excessive heat, as the hot air coming against the screen is held back by the cooler air on the opposite side and thus forms an upward current. Mr. Ellis also outlined another method which is sometimes used to protect workmen against overflow by constructing a cast iron box under the ladle in such a manner that any metal spilled cannot run over the floor and come in contact with the workmen's feet. Inexpensive devices was made a feature of the discussion and the small cost of those advocated was emphasized.

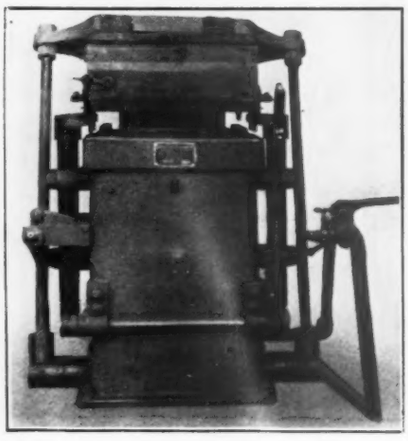


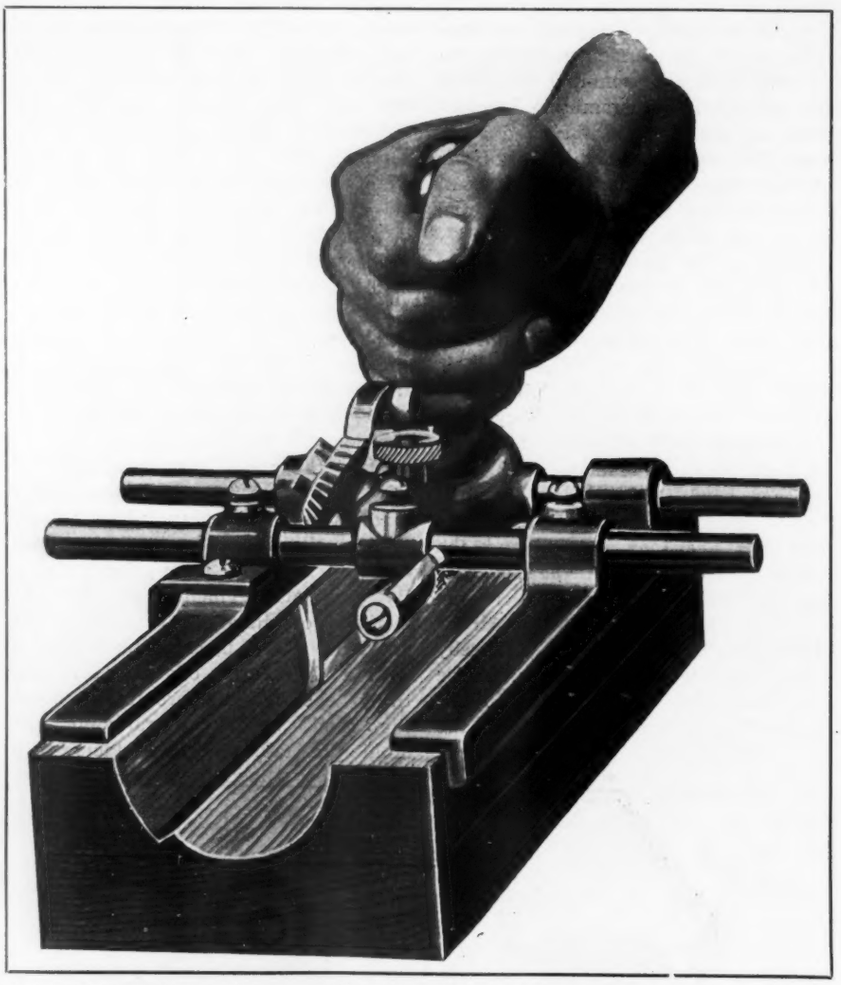
FIG. 5—MACHINE IN ORIGINAL POSITION FOR MAKING ANOTHER MOLD

## Fire Protection in Foundries

At a recent meeting of the New England Foundrymen's Association, held at Hartford, Conn., a committee was appointed to investigate the problem of better fire protection and lower insurance rates for foundry properties. The committee consists of Bartlett M. Shaw, of the Walker-Pratt Mfg. Co., chairman; George P. Aborn, of the Blake & Knowles Steam Pump Co., and Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I. It is the intention of this committee to study the subject of fire protection in foundries, with particular reference to improving conditions and thereby securing better insurance rates.

## A New Core Box Plane

A core box plane which can be used to advantage on short as well as long boxes and which cuts an accurate half circle of any desired size between ¾ and 6 inches in diameter, manufactured by the Gray Iron Casting Co., Springfield, O., is shown in the accompanying illustration. The cutter revolves automatically with each forward movement by the operator. When using the plane, a block of wood, after being cut to length and squared, is roughed out to within ½ inch of the desired diameter. The first cut with the plane is fairly heavy, while the second is light, which finishes the box. The slides should be adjusted to the width of the block, the cutter to the diameter and the handle movement, which regulates the width of cut, should be adjusted to the kind and condition of wood and the size of box and depth of cut. In one trial a core box 36 inches long, 3 inches in diameter, was planed in 21 minutes. The wood was knotty, cross-grained pine. Five cutters varying in length from ⅝ to 3¼ inches are furnished with each plane. In the accompanying illustration the plane is shown in use with a tool set to cut a diameter of 2¾ inches in a block 5 x 2¼ x 14 inches.



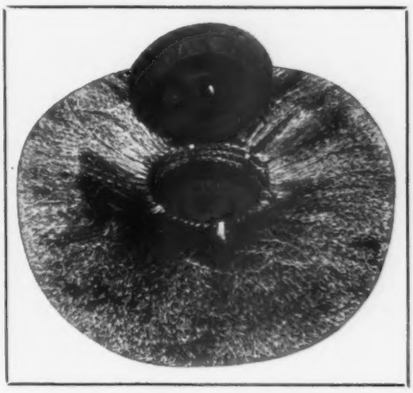
CORE BOX PLANE FOR CUTTING HALF CIRCLES BETWEEN ¾ AND 6 INCHES IN DIAMETER

BATTERY OF FOUR REEL TYPE CORE OVENS EQUIPPED WITH FIVE REELS EACH

## Reel Type Core Oven

An oven of the reel type, designed especially for baking small cores, has been added to the extensive line of furnaces and ovens built by the Rockwell Furnace Co., 26 Cortlandt street, New York City. The reels are independent of each other and operate on separate ball bearings. This permits of varying the baking time of the cores on each of the reels. One-half of each reel is in the oven and the other half outside the oven, serves as a rack and permits cores to be set in position for baking while the other half of the reel with cores is in the oven. These ovens are built for the use of fuel oil, although they can be arranged for gas, coke or coal. A battery of four ovens is shown in the accompanying illustration, each chamber being equipped with five reels, the entire battery being fired below the floor level. The oven is built of red brick and is supported by reinforced angles and tie rods so arranged that the steel frame is self-supporting. The reels or shelves are 4 feet, 11½ inches in diameter and are made of cast iron. Each half contains an area of over 9 square feet and suitable seals are provided to prevent loss of heat. To facilitate repairs the reels are made in halves and are so arranged that one-half of the complete reel or all of the reels may be quickly removed. The combustion chamber, built of fire brick, is located below the oven proper and is separated therefrom by a perforated refractory tile arch. The heat passes through the openings in the arch, heating every portion of the oven uniformly. A vent flue pipe is provided for each chamber, equipped with a sliding damper to permit of the escape of the vapors in the oven.

The number of reels and the distance between them vertically, may be arranged for any height of cores. The distance from the floor line to the top of the first reel is 12⅜ inches for an oven with a combustion chamber under the floor level and 35 inches for an oven with the combustion chamber above the floor line. Standard vertical reels are spaced as follows: 5¼, 7⅜, 8⅞, 9⅛, 11⅛, 14⅛ and 22⅛ inches. These measurements are taken from the top of one reel to the bottom of the next reel.



WIRE SCRATCH BRUSH

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John G. Bradley has been elected president and general manager of the Pratt & Letchworth Co., Buffalo.

## A Novel Wire Scratch Brush

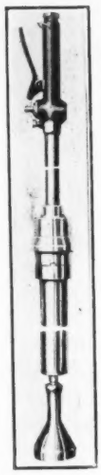
A circular, power-driven wire scratch brush, embodying novel features of construction, manufactured by the Simplex Brush Co., Cleveland, is shown in the accompanying illustration. It consists of a number of rings of bristles which may be built into a brush of any required thickness. It is held together by clamps on the inside of the ring so formed and also by the clamping action of the hub produced by the tightening nut on the driving spindle, which forces the two halves of the hub together. This brush is adapted for all operations to which a circular scratch brush can be applied such as removing the scale and sand from castings, cleaning metal patterns and sheet metal goods, and for removing the scale from hot forgings. The bristles are secured by two strands of heavy steel wire twisted together, between which the bristles are entwined. The twisted wire is then formed into a ring of standard size and the point of juncture is electrically-welded.

Each brush is composed of a number of these sections, held together by flat steel clamps which are applied by pressure, firmly binding the rings together. The hub consists of two interchangeable-flanged discs, with a hub in the center bored to fit the spindle of the machine. The discs are adjusted from opposite sides of the brush and are forced together when the brush is attached to the spindle of the machine. The flanges of the hub fit inside of the

wire rings composing the brush, and are recessed to slide over the clamps. The sectional arrangement of the brush permits any part to be replaced when worn. The hubs can be used indefinitely and the change from an old brush to a new one can be made quickly.

## Pneumatic Floor Rammer

A new type of pneumatic floor rammer, which is exceedingly light in weight and operates at a high speed without vibration, is shown in the accompanying illustration. The employment of a grooved rod prevents it from turning when in operation, except when the operator desires to turn the rammer. The piston rods are provided with a packing of a resilient nature, which does not retard the speed of the rammer or the power of the blow. However, it prevents dirt from getting into the piston chamber and cutting the operating parts. This rammer is equipped with an exhaust deflector, which prevents the exhaust air from blowing out onto the operator. These sand rammers are made in two sizes and are furnished with either round or grooved rod, as preferred, and butt and pein. The rammers are built by the Cleveland Pneumatic Tool Co., Cleveland.



## Personal

W. H. Harris, formerly foreman of the Miller Iron Co.'s foundry, Providence, R. I., has accepted a position as foreman of the foundry operated by the Lyon Iron Works, Greene, N. Y.

Harry Scullin, president of the Scullin-Gallagher Iron & Steel Co., St. Louis, manufacturer of open-hearth steel castings, sailed for Europe on Saturday, June 15. Mr. Scullin was accompanied by his wife and expects to be away for several months, visiting points of interest in Africa, Asia, as well as Europe.

E. F. Lake, consulting metallurgist, Bayonne, N. J., has merged his business with that of Nixon & Raab, and the consolidation will be known as Lake, Nixon & Raab, with offices at 156 Fairview avenue, South Orange, N. J. This firm will specialize in die-casting machinery, alloys and processes, heat treatment of steel, and advice will be given as to the best methods to be employed in melting, alloying, casting, forging, welding, galvanizing, plating, etc., either ferrous or non-ferrous metals or alloys.

# General Industrial Notes

The Breslin Boiler Works will erect a new foundry at Fort Smith, Ark.

The Iowa Iron & Metal Co., Des Moines, Ia., contemplates the erection of a foundry at San Diego, Cal.

The plant of the Albany Foundry & Nickel Plate Co., Albany, N. Y., recently destroyed by fire, will be rebuilt.

The Gile Boat & Engine Co., Ludington, Mich., whose brass foundry was recently destroyed by fire, will rebuild the plant.

The Peters Pump Co., Kewanee, Ill., will erect an addition to its foundry, 50 x 50 feet, which will increase the floor capacity 50 per cent.

The Alton's Foundry & Machine Works, Lancaster, O., is making extensive improvements to its plant, including the erection of an addition to its foundry.

The Maynard Steel Castings Co., Milwaukee, has been incorporated with a capital of $10,000. The incorporators are E. E. Shields, L. Bergner and Julius K. Fons.

The A. & F. Brown Co., 172 Fulton street, New York City, manufacturer of pulleys, has commenced work on an addition, 90 x 160 feet, to its foundry at Elizabeth, N. J.

The Schwartz Foundry Co., Detroit, will erect a foundry, 107 x 133 feet. The new building will be of brick construction and will be located on Fort street, near Twelfth.

A new foundry has been erected at Altoona, Pa., which will be operated under the name of the Westmont Iron Foundry. The shop has been placed in operation by Geo. Lebig.

The Modern Foundry Co., Oakley, Cincinnati, will shortly erect an addition to its foundry, 36 x 190 feet. Considerable new equipment will be purchased for the new building.

The Sterling Steel Foundry Co., Braddock, Pa., recently increased its capital from $250,000 to $500,000 to defray the cost of erecting additions to its plant and installing new equipment.

The Standard Malleable Iron Co., Columbus, O., has been incorporated with a capital of $10,000. The incorporators are F. A. Miller, Wm. Deeds, R. H. Platt, J. M. Henderson and R. C. Vance.

The Frontier Brass Foundry, Inc., Niagara Falls, N. Y., has been incorporated with a capital of $25,000 to engage in the manufacture of brass castings. The incorporators are J. Lebherz, R. Phipps and G. W. Knox.

The City Brass Foundry, Woonsocket, R. I., is the name of a new concern established by Benj. P. Lipp, formerly of Waltham, Mass. The foundry will engage in the manufacture of brass and bronze castings.

The American Radiator Co. of Canada, Ltd., recently incorporated at Brantford, Ont., will take over the plant and business of the American Radiator Co. which has been operating at Brantford for a number of years.

The Gibbes Machinery Co., Columbia, S. C., will erect a new plant to replace its factory destroyed by fire some months ago. The foundry and machine shop will be erected first and will be of fireproof mill construction.

The Jas. Metcalf Foundry Co., Newark, N. J., has been incorporated with a capital of $50,000 to engage in the manufacture of gray iron castings. The incorporators are J. Metcalf, A. Hammond and J. Thomson Kearny.

The Mansfield Foundry & Machine Co., Mansfield, O., has been incorporated with a capital of $10,000 to engage in the manufacture of gray iron castings. The incorporators are Oscar and Arthur Jacobs and Harry Krum.

The Southern Steel & Iron Works, Jacksonville, Fla., has been incorporated with a capital of $250,000 to engage in the manufacture of iron, steel, bronze and aluminum castings. The new company will absorb the Jacksonville Iron Works.

The Alverton Iron Works, Alverton, Pa., has purchased the plant of the National Foundry Co., Connellsville, Pa., which has not been in operation for several years. The foundry is equipped for the manufacture of gray iron castings.

The Bowler Foundry Co., Cleveland, is erecting a small addition to its foundry and will install a new cupola and a charging outfit, in addition to motor drives on all machinery, power for which will be furnished by a 250-horsepower Bruce-Macbeth gas engine.

The Michigan Steel Castings Co., Detroit, contemplates the erection of another addition to its foundry, 90 x 150 feet, of steel and brick construction. A large converter and several electric traveling cranes will be installed.

The Wise Furnace Co., Akron, O., will shortly erect a new foundry, 150 x 200 feet, of steel and reinforced concrete construction. In addition to the foundry a machine shop, warehouse, shipping department, etc., will be erected.

The Michigan Steel Casting Co., Detroit, is erecting an addition, 175 x 90 feet, to its foundry. The building will be of brick and steel construction. Two electric cranes and an additional converter with all the necessary equipment, such as blowers and cupola, will be installed.

The American Brass & Iron Co., Detroit, will erect a foundry, 38 x 82 feet, on the northwest corner of Crystal and Trombly avenues. The building will be of reinforced concrete construction with tile and concrete roofing, the walls and foundations being of sufficient strength to support two additional stories.

The Carolina Machinery & Foundry Co., Asheville, N. C., has purchased the foundry of the American Supply & Foundry Co. Several thousand dollars worth of new equipment will be purchased and extensive improvements will be made to the buildings. The new foundry will be under the management of Messrs. Sternberg and Decker.

The General Aluminum & Brass Castings Co., Detroit, has been incorporated with a capital of $75,000 by Frank C. Root, formerly connected with the Aluminum Castings Co. The new company has secured a site covering three acres at St. Aubin avenue and East Boulevard and a one-story steel and concrete foundry, 120 x 200 feet, will be erected. The officers of the company are J. A. Rutherford, president; F. C. Root, vice president, and H. P. McIntosh Jr., secretary.

William Nixon and Robert Glascoff, Albion, Mich., have acquired the Cook Mfg. Co.'s foundry from the C. C. Wormer Machinery Co. of Detroit. The foundry will be operated under the name of Nixon & Glascoff and will do a general jobbing business, as well as supply the Wormer company with the castings required in their wind mill departments. Mr. Nixon was formerly associated with the Gale Mfg. Co. and Mr. Glascoff has been head of the Cook company's foundry for some time.